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THE NAIADES OF MISSOURI.—II.

BY WILLIAM I. UTTERBACK.

CATALOGUE OF THE NAIADES OF MISSOURI.

FAMILY I. **Margaritanidae** Ortmann.

1911—*Margaritanidae* Ortmann., Nautilus, Feb.

"Diaphragm incomplete, formed only by the outer gills; outer laminae of outer gills only in part connected with the mantle, posteriorly free for considerable distance. Anterior end of inner gills separated from the palpi by a wide gap. The margins of the mantle do not unite or approach each other anywhere and there is no tendency to form branchial and anal siphons and no supra-anal opening is present. Gills without water-tubes, inter-lamellar connections forming oblique rows. Marsupium formed by all four gills. Glochidia small, semicircular and globular, without hooks, but with irregular, small teeth at the ventral margin."—*Ortmann (1912 b, p. 223).*

This Family presents the most primitive characters of the *Naiades* and is represented in Missouri by only one species, *Cumberlandia monodonta* (Say), for which it was necessary to create a special genus because of its peculiar gill structure as determined by histological studies. Even in this Family, shell characters are not constant enough to be considered in the diagnosis. Like the sub-families, *Unioninae* and *Anodontinae* of *Unionidae*, the glochidal discharge is effected through the anal opening.

Genus **Cumberlandia** Ortmann.

18912a—*Cumberlandia* Ortmann, Nautilus, XXVI pp 13 and 14.

(Type, *Unio monodonta* Say.)

ANIMAL CHARACTERS:—Diaphragm and supra-anal opening absent; gills long and narrow, inner broader anteriorily than outer, inter-laminar connections not irregularly distributed but arranged obliquely parallel to each other, outer lamina of outer gill free from mantle posteriorly, inner lamina of inner gill almost entirely free from visceral mass; all four gills marsupial; anterior adductors reinforced posteriorly.

SHELL CHARACTERS:—Shell narrowly elliptical, no sculpture on disk, low beaks scuptured with ridges parallel with growth lines; epidermis black; anterior cardinals lacking, posterior ones conical; anterior adductor muscle scar deeply impressed post-dorsad; nacre pearl blue to white.

Cumberlandia monodonta (Say).

("Spectacle Case.")

Pl. XV. Figs. 28A and B.

1829—*Unio monodonta* Say, N. Harm. Diss., IIp. 293; 1830, Am. Conch I. Pl. VI.

1853—*Margaritana monodonta* Conrad, Pr. Ac. N. Sci., Phila. VI, p 262.

1912a—*Cumberlandia monodonta* Ortmann, Nautilus XXVI, pp 13 and 14.

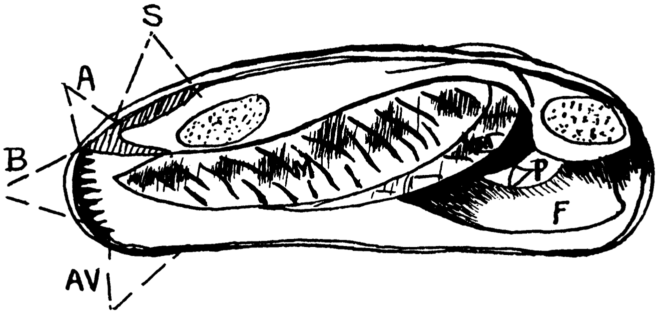

FIG. 1.—*Cumberlandia monodonta* (Say). ♀ Diagram of sterile individual from the Osage River, Sagrada, Mo., showing animal characters in left valve. (Nat. size.)

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening with papillae reduced to mere crenulations; no gill partition (diaphragm) between branchial and anal openings; no *true* supra-anal opening; gills very long and narrow with interlaminar connections regularly arranged as "continuous septa which run obliquely forwards;" inner lamina of inner gill free from visceral mass except at its anterior end; outer lamina of outer gill slightly free posteriorly from mantle, all four gills marsupial; palpi, large, comparatively broad, hangs low, united two-thirds of way toward base; color of soft parts soiled white, mantle edge blackish chiefly at the branchial openings.

REPRODUCTIVE STRUCTURES:—No gravid females found so far.[1] The gills of several specimens from the Mississippi River presented no variations of structure; hence this peculiar oblique arrangement of septa may not be a sex distinction.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Elongate-elliptical, arcuate in old specimens, not sexually dimorphic; rounded before, usually more pointed behind; beaks small, low, sculptured by a few coarse concentric bars; lines of growth rough, coarse; epidermis black, shell moderately thick anteriorly, but very thin posteriorly, being disposed to crack easily upon exposure to air.

INTERNAL STRUCTURES:—Cardinals conical, single in both valves, rudimentary to lacking in left; laterals low, single in right, inclined to double posteriorly in left; scars well impressed anteriorly—especially the one taking the position of anterior cardinals in most other *Naiad* shells; beak cavities shallow; nacre bluish with a slight tint of salmon in umbonal cavity; no vein marking as in most *Unioninae.*

♀	115	x	44.5	x	25mm	(Osage R., Bagnell, Mo.)
♂	127	x	45	x	27.5mm	(" " Sagrada, Mo.)
♀	122	x	47	x	26mm	(Miss. R., Louisiana, Mo.)
♂	96	x	40	x	20.5mm	(Miss. R., Louisiana, Mo.)

MISCELLANEOUS REMARKS:—*C. monodonta* is most typical in the Mississippi above the mouth of the Missouri. Bryant Walker records it from Tennessee to Ohio, thence Northwestward to Nebraska. From the fact that the author found this primitive species at several points in the Osage and Gasconade Rivers, *its known distribution is now carried farther south and west of the Mississippi River, than recorded before.* The existence of this, as well as other primitive forms of the *Naiades*, also in the Cumberland-

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[1] Dr. A. D. Howard, (Scientific Assistant, U. S. Biological Station, Fairport, Iowa), has however recently discovered that this species bears unusually small glochidia and has the peculiar habit of bearing two broods in a season (Nautilus, XXIX, p. 6, May, 1915.)

Tennessee basin may furnish some interesting data for the reconstruction of ancient geographical features for the central Mississippi Valley.

FAMILY II. **Unionidae** Swainson (restricted).

"Diaphragm complete, formed only by the gills; the outer lamina of the outer gills connected with the mantle at its posterior end. Anterior end of inner gills separated from palpi by a more or less wide gap. Margins of the mantle held together by the gill-diaphragm, but not united, thus separating the anal from the branchial opening, and the anal is generally closed above by the union of the margins of the mantle, (it rarely remains open), and when closed, it always leaves a supra-anal opening (which is very rarely obliterated). Gills always with water tubes formed by interlamellar connections developed as continuous septa, running parallel to the gill-filaments. Marsupium formed by all four gills, or by the outer gills alone, or by parts of the outer gills. Glochidia of various shapes, suboval, or subtriangular, or celt-shaped, with or without hooks on the ventral margin."—(Ortmann 1912b.)

Simpson's terse diagnosis of this family is:—"Hinge with schizodont teeth; embryo a glochidium."

The family, *Unionidae,* naturally falls, into three divisions on the basis of physiological and morphological characters; however, this family may fall into two sub-divisions on the sole basis of reproductive functions. The *Unioninae* and *Anodontinae* would form the first and the *Lampsilinae* the second group from the fact that the discharge of the glochidia takes place in the former through the primitive and natural way of passage from the ovisacs through natural openings into the suprabranchial canals and then on out through the anal opening and in the latter the discharge is effected in a more direct and seemingly unnatural manner; that is, in the passage from openings forced through the ventral edges of the ovisacs, and thence out through the branchial opening. Yet the two sub-families, *Unioninae* and *Anadontinae,* have morphological differences in marsupial characters and in structures of the glochidial masses that are correlated with physiological differentiation in breeding habits. On the same grounds, *Lampsilinae* is set aside as well a defined group; however the latter, although the modern group, is related to the primitive one *Unioni-*

nae, in that the morphology of the Lampsiline glochidium would indicate a reversion to the primitive type as is the natural course in the cycle of evolution. Thus on the basis of glochidial characters, the Family Unionidae may be grouped as:

1 ANODONTA, bearing non-conglutinated glochidia, spadiform, spined.

2. PROPTERA, bearing conglutinated glochidia, celtiform, spined or spineless.

3. UNIO-LAMPSILIS, bearing conglutinated glochidia, apronform, spineless.

The key to the whole situation governing the approach to the modern arrangement is in the differentiation of structures for the benefit of the embryos; e. g., large palpi for the *Unioninae*, marsupial water tubes (secondary) and also large palpi for *Anodontinae*, but, best of all, an adjustment of marsupium near to a specialized mantle edge in form of flaps, papillae, tentacles, etc., as shown in *Lampsilinae*.

I—SUB-FAMILY **Unioninae** Ortmann.

1911a—*Unioninae* Ortmann. An. Car. Mus., IV, pp. 335–336; 1912b An. Car. Mus. VIII, pp. 236–277.

ANIMAL CHARACTERS:—Branchial opening rather sparingly papillose; anal smooth to finely crennulate; supra-anal usually present separated from anal by very short or moderately long mantle connection; no tendency to form tubular siphonal openings; inner laminae of inner gills free from visceral mass; palpi usually very large and long, marsupium occupying all four gills or by the two outer ones, when gravid not much swollen, ventral edge pointed, never bluntly distended and secondary water-tubes never developed lateral to the ovisacs within; mantle edge anteroventrad to branchial opening, smooth; glochidia of the *Lampsilis* type, apron-shaped, small to medium, semicircular or semielliptical, ventral margin rounded, without spines; conglutinates well formed.

SHELL CHARACTERS:—Forms of shell various, usually thick; disk smooth to very profusely scuptured; beaks usually scuptured with concentric or zigzag ridges; hinge teeth very highly developed, cardinals and laterals never lacking; scars well impressed.

MISCELLANEOUS REMARKS:—The soft anatomy of the species of this subfamily are rather constant. However, its shell characters are so inconstant that this subfamily may be termed a great group of intergrades. Having very typical hinge teeth and very closely adhering valves the branchial margins are not well papillosed and the soft parts of the different species are more or less identical. In contrast with the other more modern subfamilies, *Anodontinae* and *Lampsilinae*, a greater differentiation of soft parts is noted in the latter, due to their more gaping valves and to a greater adjustment to aeration of the embryos; then, too, *Unioninae* differs from either of the two in that its breeding season is short (tachytictic), being confined to the summer. In the *Unionae* the color, form and solidity of the conglutinates can be considered as of greater systematic value than in the other sub-groups. It is to be noted that these summer breeders have the peculiar trait of aborting their conglutinates when they may be disturbed from their natural beds. The fact of the close, or even deciduous, mantle connection between the anal and the supra-anal openings may be a minor character in distinguishing the genera. The connection between inner laminae of the inner gills and the visceral mass may also serve in making distinction. From the fact that there are a great number of variations in shell character for this sub-family it is necessary to admit several genera so that there may not be so much opportunity for the same types of shell to turn up and thus give false impressions of relationships. It is very striking to note the atavism of the spineless, subovate glochidium of this sub-family in the fact of its homologous recurrence under the *Lampsilis* type. However, this natural reversion to primitive type in the embryo of the *Lampsilinae* is only an indication of the wide gap between the two sub-families as well as in the fact of its differences of physiological characters in the adult, such as the discharge of glochidia through the anal opening for the *Unioninae* and through the branchial for the *Lampsilinae*. However the homologous differences in the soft parts and hard parts of the two groups are still greater than the analogous. Why more species of this primitive group should occur in the more modern region of this state (i. e., N. Mo., the New Prairies) than in that of the more ancient geologic formation (i. e., S. Mo.,—the Ozark Uplift)—this is a problem that the author is trying to solve. The unusual variations within the sub-family especially is another problem that would also be solved.

Genus **Fusconaia** Simpson.

1900b—*Fusconaia* Simpson, Pr. U. S. Nat. Mus. XXII, p. 784 (as sect.)
1912b—*Fusconaia* (Simpson) Ortmann, An. Car., Mus., VIII, pp. 240–241.

(Tpye *Unio undatus* Barnes).

ANIMAL CHARACTERS:—Branchial opening with dense yellowish tentacles; anal smooth; supra-anal separated from anal by very short connection, laminae of inner gills free from visceral mass; palpi rather large; all four gills marsupial, ovisacs when gravid subcylindrical; conglutinates same shape, usually reddish, subsolid and discharged whole; glochidium subovate, somewhat small, spineless; colors of soft parts usually brilliant, such as orange or red.

SHELL CHARACTERS:—Shell roundly quadrate or triangular; disk smooth; beaks elevated, sculptured with concentric ridges angled at base of prominent post-umbonal ridge; epidermis reddish to brown with fine, rather interrupted, rays when young; hinge teeth well developed; beak cavities deep; nacre white.

MISCELLANEOUS REMARKS:—Dr. Ortmann considers this genus the most primitive of the *Unionidae* and limits it to those species of Simpson's *trigona* group that possess subcylindrical conglutinates and ovisacs, concentric beak sculpture and smooth disk as the diagnostic features. While the conglutinates of the *Fusconaia* species may be reddish, yet they may vary from pale pink to white due to their development usually. It is to be noted, however, that when the conglutinates are white all of the anatomy is also white; when the conglutinates are reddish the soft parts will be more yellowish. In this state the following groups may differ morphologically and ecologically as follows:

1. F. *undata:* swollen, high beaks, mostly greenish—black epidermis . . . . Big Rivers
2. *F. trigona:* swollen, lower beaks, mostly reddish epidermis . . . . Medium Rivers
3. *F. flava:* flat, low beaks, always reddish epidermis Small Rivers

The second group is not found in very typical form in this State, but is represented by intergrading forms. In fact none of these Species, representing the above names, are very often found typical in Missouri, since this State seems to be the home mostly for intermediate forms not only for *Fusconaia*, but for other Genera of this Sub-family, *Unioninae*, especially. All *Fusconaia* of this State are strictly fluviatile. For the most part the Species of this Genus are *hermaphroditic*, for all localities.

Fusconaia undata (Barnes).

("'Pigtoe.")

Pl. xv. Figs. 29 A and B.

1823—*Unio undatus* Barnes, Am. Jour. Sci., VI, p. 121, pl., iV, fig. 4.
1831—*Unio trigonus* Lea, Tr. Am. Phil. Soc., IV, p. 110, pl XVI, fig. 40.
1900b—*Quadrula trigona*, Simpson, Proc. U. S. Nat. Mus., XXII, p.,787.
1900—*Quadrula undata* Walker, Nautilus, XXIV, pp. 5-11 and 16-24, Plates I and I.
1912b—*Fusconia undata* (Barnes) Ortmann An. Car. Mus., VIII, p. 241.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES—Branchial opening with short brownish papillae; anal slightly papillose, separated from supra-anal by very short,—even deciduous—mantle connection; inner gills larger, inner laminae free from visceral mass; outer gill undulate antero-ventrad, palpi moderately large, connected over half of their length antero-dorsad; most of soft parts yellowish or cream colored.

REPRODUCTIVE STRUCTURES:—Marsupia formed by all four gills, when charged not distended, lumen of ovisacs subcylindrical; conglutinates same form, light red—even to white—according to age of embryos; glochidium semicircular, medium size, hinge line nearly straight, length and height, (0.160 x 0.155mm), about same.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell trigonal, thick, heavy anteriorly, disk smooth; beaks high, full, pitched slightly beyond anterior end, sculptured with concentric ridges breaking into nodules at base of prominent umbonal ridge; dorsal line bowed, post-ventral line with long gentle incurve; broad shallow valley in front of post-umbonal ridge; ventral margin bowed in semicircular form; epidermis greenish to rusty brown or black or mingling of both green and black; rest lines furrowed giving an undulated effect; post-umbonal ridge prominent.

INTERNAL STRUCTURES:—Cardinals single and pyramidal in right, double and roughly socketed in left; laterals double in both valves; scars deeply impressed; beak cavity narrowly deep; nacre silvery white; male shell usually more compressed than that of female, but no true dimorphism shown.

Length		Width		Diameter	Um. ra.	Locality.
75	x	63	x	48mm	0.16	(Miss. R., LaGrange, Mo.)
70	x	64	x	49mm	0.78	(" " " "
55	x	43	x	39mm	0.17	(Meramec, R., Fern Glen. Mo.)
60	x	55	x	46mm	0.17	(Osage R., Linn Cr., Mo.)

Juvenile Shells are described as having a light yellowish brown epidermis with green rays most distinct on anterior slope, and finely ribbed lines running from beaks to ventral margin across center of disk.

MISCELLANEOUS REMARKS:—This species was hidden in synonomy for many years until Mr. Bryant Walker (1910b, p. 5) brought it to light through diligent study. It is found in most typical form in the Mississippi River and occasionally it may be found in the Meramec and Osage Rivers where it is to be distinguished from *F. flava* by its swollen high beaks and darker epidermis. Then, too, this species is determined largely ecologically, being an inhabitant of the large streams and deep water, for the most part. In most of the interior streams of the state, *undata*, however, is found chiefly in an intermediate, or intergraded, form with *flava*. In the whole southwest this species does not seem to be very near the type as found in the Ohio drainage or in the Upper Mississippi, especially in Wisconsin where Barnes secured his type lots. The Des Moines River, Clark Co., Mo., has produced rather good types, some shells of which have been sent to the National Museum by Mr. B. F. Bush and are now on exhibit there under the number 132, 633. However, none of these so-called *undata* types come up to those of the Upper Mississippi. Surber (1913, p. 113) finds *F. undata* in the larval state to be a gill parasite on the black crappie (*Pomoxis sparoides*) as an occasional host. *Undata* is a tachytictic form, but begins its breeding very early, bearing glochidia June, July and August and hence has an unusually long period for a summer breeder. The writer has observed that during the first part of the breeding season, when the ova are bright carmine color, that not only the marsupium but also the nutritive parts—especially the foot are also a brighter color—chiefly orange—than at the end of the season when most of the anatomy has a brownish or soiled white color.

Before maturity the glochidia have been observed to be yellowish brown and contained in pinkish sacs.

Fusconaia undata trigona (Lea).

("Little Pigtoe.")

Pl. xv. Figs. 31 A and B.

1913a—*Fusconaia undata trigona* (Lea) Ortmann, Pr. Am. Phil. Soc., LII, No. 210.

ANIMAL CHARACTERS.

The nutritive and reproductive structures of this subspecies are, of course, identical with those of its species.

SHELL CHARACTERS.

Shell more quadrate than that of *F. flava*, post-umbonal ridge not so prominent, more solid anteriorly, higher fuller beaks, epidermis darker. Compared to its typical species it never matures to be as large, nor as heavy, is not quite so upright, nor as inflated, has lower beaks and more of a reddish epidermis. The internal shell structures are identical with those of its species. From the subspecies, *trigonoides*, it differs chiefly in being more upright, not so elongated, nor as large.

Length	Height	Diameter	Locality
65 x	53.5 x	41mm	(Osage, R., Sagrada, Mo.)
60 x	50. x	32mm	(" " Monegaw Springs, Mo.)
60 x	54 x	34mm	(" " Warsaw, Mo.)
48.5 x	40 x	26mm	(" " Linn Creek, Mo.)

MISCELLANEOUS REMARKS:—This sub-species is one of the decided intergrades for *F. undata* and *flava* and is the most common form in the interior streams of the state—especially in the Osage where the writer, in a 300 mile survey by boat, made a thorough study of them to find the interior of shell and soft parts to be identical with those of the species; however, none of these forms were found with reddish conglutinates, nor yellowish soft parts. Probably this whitish colorization was due to the advanced stage of gravidity in which they happened to be found when they were encountered between the upper and lower stretches of the river. at the latter part of July. This variety of *undata* may be ecologically determined as a dweller in medium sized rivers, or, if found in a large river, in medium stream conditions. This is found to be the case in the Osage, for the more the mouth is approached the more this form is supplanted by the heavier, more inflated and more typical shell of the main species. This subspecies, however, is more like the type than the *trigonoides* of Frierson, the latter being more nearly the *flava* type and hence might be well named "*F. undata flava* (Raf.)"

Fusconaia undata trigonoides Frierson, MS.

("Big Pigtoe.")

Pl. XV—Figs. 30 A—D; Pl. IV, Figs. 9a, and 9b.

1913—*Fusconaia undata trigonoides* Frierson MS.—Personal Letter, February 22, 1913.

ANIMAL CHARACTER:—Soft parts indentical with species. Glochidium measures 0.180 x 0.165mm; conglutinates white in glochidial and late embroyonic stages, pink in earlier stages.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell elongate trigonal, thick, heavy, very large for the genus; disk without sculpturing except that rest-lines are somewhat furrowed giving an undulate appearance to growth lines; beaks comparatively low and not placed so much anteriorly, sculptured with concentric bars breaking into two or three nodules at base of post-umbonal ridge; post-dorsal part of shell, bowed, slightly biangulated behind; epidermis cloth-like, reddish brown to horse bay color, rayed in young.

INTERNAL STRUCTURES:—Identical with those of the species and other intergrading forms, except that it may vary from a white to pink nacre.

Length		Width		Diameter	Location
93	x	66	x	42	(Platte R., Dixon Falls, Mo.)
70	x	50	x	38	(Osage R., Schell City, Mo.)
50	x	40	x	24	(Osage R., Warsaw, Mo.)
28	x	20	x	14	(Platte R., Garretsburg, Mo.)

The juvenile indicated by the measurement under the last number was found lying on its side in the shallow water of a riffle. It is different from the mature shell in its dark yellow epidermis marked all over by green rays, also by more prominent umbonal ridge, more centrally placed and more distinctly sculptured beaks. The soft parts are all of a bright orange color except the bluish visceral mass.

This specimen and also the one under the first measurement of the above list were kindly indentified by Dr. Ortmann as *F.*

undata rubiginosa (Lea) a name which this form might well bear because of its closer relation with *F. flava* (Raf.) [=*F. rubiginosa* (Lea)]. After a prolonged correspondence among Messrs. Simpson, Walker and Frierson this rather common and peculiar form was left to the latter for naming; hence the MS. name herein given.

MISCELLANEOUS REMARKS:—This intergrade is very near the form, *undata-trigona*, and differs only in being more elongated, less upright, more rounded, post-dorsal margin, more reddish epidermis, lower beaks, and is a larger, heavier shell. Those of this variety that are found in the Mo. Platte of North Mo. have the most ponderous shell of any of the *Fusconaia*—some reaching a length of 100mm while the average length of the species (*F. undata*) for the Mississippi only average 60mm. This variety seems to be more of a creek form of *F. flava* and the reason for this form being larger in the Platte R., a smaller stream, than in the Osage, the largest tributary of the Missouri in this State, may be traced as a mere local effect since the shells of other species in the Mo. Platte are found to be abnormally large. Like most of the *Unioninae* this form has a peculiar habit of aborting its conglutinates when taken from its natural bed. The author has been able to pick out for study the little pink club-shaped conglutinates from whole masses of other white leaf-shaped conglutinates of *Quadrulae* or *Pleurobemae* that would also be aborted after being collected from the river and placed in a tub or aquarium. The habits of this form are that of deep and rapid burrowers and inhabitants of deep water and coarse gravelly bottom. It is found to be gravid from May until September and sterile for the rest of the year. A proposed publication by Mr. Frierson on these puzzling southwestern forms of *Fusconaia* will, without doubt, clear up the situation.

Fusconaia flava (Rafinesque.)

(Pigtoe," "Red Shell," "Red Nose," "Wabash Pigtoe.")

Pl. XV. Figs. 32 A—D.

1820—*Unio flavus* Rafinesque, Monog. Bio. Shells of R. Ohio.

1829—*Unio rubiginosa* Lea, Tr. Am. Phil. Soc., III, p. 427. Pl. VIII, fig. 10.

1898—*Quadrula rubiginosa* Baker, Moll. Chicago. Pt. I. p. 77, Pl. XIX, fig. 1; XX, fig. 1.

1912—*Fusconaia rubiginosa* Ortmann, An. Car. Mus., VIII, pp. 241 242, Text Fig. 4.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening with papillae on inner edge, anal with fine but distinct papillae; supra-anal long and large with very short connection of mantle edge; gills sharply pointed behind with wide space between the anterior attachment to mantle and base of the palpi, inner laminae of the inner gills entirely free from visceral mass; palpi rather large, subfalcate; color of soft parts variable, but usually orange yellow especially the distal end of foot, also mantle edge and adductors, while sterile gills are brownish.

REPRODUCTIVE STRUCTURES:—Marsupia with crowded septa dividing the ovisacs parallel to the gill filaments; when charged, lumen of ovisacs somewhat cylindrical containing club-shaped conglutinates which are carmine red or pinkish to whitish in color; glochidia somewhat small, semicircular, spineless, hinge line nearly straight, about as long as high (0.150 x 0.155mm).

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell trigonal-quadrate, rather thick, compressed, rather rounded post-dorsad, gently curved ventrad; disk somewhat undulated by growth lines; beaks not very high or full, sculptured by concentric ridges breaking into 2 or 3 nodules at base of posterior ridge; this post-umbonal ridge usually flattened; epidermis yellowish to dark horn color, rayed in well preserved and young shells, eradiate in old.

INTERNAL STRUCTURES:—Cardinals double in both valves; laterals long, serrated; scars well impressed; beak cavity narrowly deep; nacre mostly white, sometimes tinged with salmon in beak and antero-branchial cavities, irridescent.

Length		Width		Diameter	Locality.
65	x	45	x	30mm	(St. Francis River, Greensville, Mo.)
43	x	35	x	25mm	(" " " " "
50	x	40	x	24mm	(White River, Hollister, Mo.)
34	x	27	x	16mm	(" " " ")

This latter measurement is that of a somewhat advanced adolescent shell. However, it shows the juvenile characters of a flattened post-umbonal ridge, a rounded post-dorsal line and the very distinct concentric sculpturing on the beaks much more evidently than in the adult. The most striking characters, that are absent in the mature shell, are the green rays.

MISCELLANEOUS REMARKS:—This species is distinguished mostly from *F. undata* and the intergrades by its more quadrate and compressed form of shell, by lower beaks, and less upright position. *F. undata trigonoides* is separated from it by possessing a heavier and more elongated shell with a more prominent post-umbonal ridge and black epidermis. The White River shells, indicated in the above measurements, are rather intergrades for this species and *hebetata* and the St. Francis *flava* are too inflated to be very typical. Since this State proves to be such grounds for the inconstant occurence of types, and this species is so susceptible to intergradation, it is difficult to find a typical *flava*, such as found in the Interior Basin east of the Mississippi. Perhaps its nearest form is in drainage for the south slope of the Ozarks in this state, although Simpson reports it as having a general distribution throughout the Mississippi drainage. This distribution doubtless included its many forms. Simpson further states that the St. Lawrence River system includes *flava*. Dr. Sterki (1898, p. 30) considers this species as occasionally *hermaphroditic* by examination of its gonads. Surely *this finding can be confirmed by the forms of Missouri*, for it is *rarely that it is even locally a gonochorist*. *Flava* is typically tachytictic being only found gravid from May until August.

Fusconaia hebetata (Conrad).

Pl. XV,—Figs. 33A and B.

1854—*Unio hebetatus* Conrad., Jl. Ac. N. Sci. Phila. II, p. 296, Pl. XXVI, Fig. 5; 1888—B. H. Wright, Check List.

1900b—*Quadrula hebetata* Simpson; Proc. U. S. Nat. Mus., XXII, p. 787.

ANIMAL CHARACTERS:—The soft parts of a form of *F. hebetata*, found in the Osage River, were discovered to be indentical with those of *F. flava*.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell rather orbiculate-quadrate, thick, moderately inflated, post-umbonal ridge prominent, disk smooth,, beaks flat, and well back from the anterior end post-dorsal ridge rounded, post-ventral margin gently undulate; epidermis black with a few faint imbricated rays toward (but not across) the disk in the middle of the umbonal region.

INTERNAL STRUCTURES:—Cardinals single in right, double in left, interdentum deeply gashed in right; laterals double in left with slight tendency to double in right; umbonal cavity narrowly deep, scars deep; nacre white to pale pink.

Length	Height	Diameter	Locality.
58 x	50 x	26mm	(Osage River, Linn Creek, Mo.)

MISCELLANEOUS REMARKS:—The above measurement is that of a moderately compressed shell resembling that of some typical *hebetata* shells which are sent to the writer from Alabama and considered as types by Messrs. Wright, Walker and Simpson. The latter student (1900b, p. 787) reports the Alabama *hebetata* as also found here in Missouri, but no specific locality is given. Since there seems to be so much confusion concerning this shell of Conrad with his own *cerina* or with Lea's *rubida* it should be investigated. Probably it would be found (through longer suites of shells) that the broad compressed *flava* of the White River would either be a form of Conrad's *hebetata* or an unusual *flava* of Raflnesque, or perhaps an age-form of the latter. As matters now stand this species (if it be a good one anywhere) must be listed with some doubt for Missouri.

Fusconaia ebena (Lea).

("Nigger Head.")

1831—*Unio ebena* Lea, Trans. Am. Phil. Soc., V. p. 84, pl. IX, fig. 14.
1900b—*Quadrula ebenus,* Simpson, Proc. U. S. Nat. Mus., XXII, p. 793.
1912b—*Fusconaia ebena* (Lea) Ortmann, An. Car. Mus., VIII, p. 245.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening large with branched papillae; anal smooth or crenulated; supra-anal large briefly connected to anal by mantle edge; gills brown outer pointed anteriorly inner laminae of inner gills free from visceral mass; palpi moderately large and connected about half of their length antero-dorsad.

REPRODUCTIVE STRUCTURES:—All four gills marsupial; when charged scarlet, not distended; before gravidity ovaries carmine color; glochidium semicircular, spineless, medium size, hinge line straight but slightly oblique, length and height about equal (0.160 x 0. 15 mm), conglutinates subcylindrical, bright pink.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell thick, solid, subrotund, sometimes shows a tendency to bianguation posteriorly; beaks incurved, projecting forward, sculptured with concentric lines but no sculpturing carried out on the disk; rest lines of growth concentric and furrowed; epidermis satiny horn color.

INTERNAL STRUCTURES:—Cardinals large and massive; laterals long and heavy; interdentum broad; beak cavities deeply creviced; scars deep; nacre pure white, stippled, irridescent.

Sex	Length		Height		Diameter	Um. ra.	Locality.
♂	105	x	75	x	60mm	0.090	(Miss. R., La Grange, Mo.)
♀	95	x	65	x	57mm	0.100	(" " " " ")
♂	56	x	46	x	32mm	0.120	(" " Hannibal, Mo.)
♂	20	x	18	x	8mm	0.115	(" " " ")

The shell of the juvenile of this last measurment is so round, and with beaks so drawn up to center of dorsal line that it resembles that of a *Sphaerium.* Umbonal sculpturing not very distinct even in this juvenile. It can always be identified in the early stages of its juvenility by white spots located post-dorsad on its shell.

MISCELLANEOUS REMARKS:—The writer, after some years of extensive collecting from the largest streams of the state, has failed to find *ebena* in the interior streams, neither have any Missouri collectors, nor old "clammers" reported it. This shell is known not only for its greatest commercial value and for its rarity in general geographical distribution but also for its great abundance locally. Of course its only home, known so far, is the Mississippi north of the Missouri River. It is not known why this species does not occur for this state in those Ozark rivers that bear it in great abundance in Arkansas not far from the Missouri–Arkansas line. Sometimes a black shelled *Pleurobema pyramidatum* or *Fusconaia undata trigonoides* may be taken for the "Nigger Head" (*F. ebena*), but, from the characteristic cornucopia-form of shell, together with its deep brown satiny epidermis and regular, concentric furrowed rest lines of growth, it should be easily identified. Frierson reports *ebena* as a rare shell in Louisiana and Isely (1914, pp. 1-4) does not report it at all for the Arkansas and Red River drainages of eastern Oklahoma. Perhaps Call's account of it (1895, p. 16) as a common shell, not only for Arkansas, but for all the larger rivers west of the Mississippi, is more conjectured than real. Its breeding season has been found by Wilson and Clark (1914, p. 42) to extend from May to the middle of July. Surber

(1913, p. 104) finds the host that is the specific distributor of this valuable shell to be a fish known as "skipjack" (*Pomolobus chrysochloris*).

Genus **Amblema** Rafinesque.

1820—*Amblema* Rafinesque, Monograph Biv. Shells of R. Ohio.
1912b—*Crenodonta* (Schluter) Ortmann, An. Car. Mus., VIII, pp. 245–250.

(Type *Unio plicata* [Lesneur] Say).

ANIMAL CHARACTERS:—Branchial opening long with few small arboreal papillae; anal large, very slightly crenulated; supra-anal separated from anal by very short mantle connection, sometimes no connection at all; gills large, inner wider and longer, outer connected high up to mantle antero-ventrad, inner laminae of inner gills free from visceral mass; palpi long, falcate united most of their length antero-dorsad; marsupia occupy all four gills, ovisacs of inner being wider, when gravid ovisacs expand transversely; conglutinates white, compressed, leaf-like shape, discharged through anal passage in rather broken or loose masses; glochidia small, spineless, subovate.

SHELL CHARACTERS:—Shell subquadrate to subtrapezoidal, thick, beaks more or less elevated, sculptured with concentric lines slightly angled at the base of the post-umbonal ridge and disappearing out upon the disk or continued there in a zigzag pattern of irregular broken pustules, nodules and oblique, indulated or plicated folds, the latter being disposed across the posterior half; hinge teeth heavy and well developed; beak cavities deep crevices under rather wide interdentum; vein markings on antero-pallial margin distinct; nacre usually white.

MISCELLANEOUS REMARKS:—It is recognized by students of *Naiades* that this genus needs a thorough revision—especially as to its shell characters. Like the genus *Fusconaia*, *Amblema* is a group of all sorts of inter-grading and puzzling forms. However, for this State it is not so much a question of facts regarding a predominance of these plicated forms for the different faunae as it is an application of these varieties to the present chaotic nomenclature for this genus. As nearly as the writer is able to determine, after a correspondence with students and a thorough study of literature and actual field conditions, the present status of affairs would group the species and other allied forms of *Amblema* *for North Missouri* under the so-called *plicata* (Say) types, for the most part; those of *Central Missouri under both types of plicata and the better known undulata* (*Barnes*), and those *of Southern Missouri under undulata.* These facts might be accounted for by the natural physiological adjustment to ecological conditions—that is to say, the quiet, sluggish, muddy streams of North Missouri tend to produce a heavy, inflated, rarely plicated shell, mostly represented by *Amb. rariplicata* of Deshayes; on the other hand, the swift, clear water streams of South Missouri have the tendency to shape up a compressed and multi-plicated shell best represented by *Amb. perplicata quintardi* of Cragin, while the intermediate or combined ecological conditions of Central Missouri give combinations of these two extremes. In the grouping of the members of this genus there has been much necessary elimination of local varieties and races and thus types have been adherred to as much as possible. The arrangement is only submitted as tentative due to the doubt of the present nomenclatural situation. This problem may be easily solved if it may be found that the morphology of shell characters may be traced, in most instances, to ecology. Probably this solution may be accomplished by studies of closely connected series from the glochidial to the mature shell. Our judgment, from studies of local conditions in this state, would be that the obliquely undulated and plicated folds, forming the chief shell character of this genus, are more developed in swifter current as a physical adaptation for survival by the way of more permanent anchorage, etc., just as we may account for the pustulate and nodulous characters of the shell instead of considering them as mere characteristic markings. However, when it has been found that the *beak sculpture* (*the most constant shell character*) of *Amb. plicata* (Say) and *costata* (Raf) [=*undulatus* (Barnes)] are really different and that there has been a differentiation from the adolescent shells to the mature ones we are compelled to recognize genetic distinctions in these two species. Yet it seems that it may be safely stated that two such well defined groups are connected in all manner of inter-grades through environmental causes such as seen in the different ecological provinces of Missouri. It is found that this genus has a short period breeding season, that the white, leaf-shaped conglutinates are discharged by the natural outlet of the anal opening and that these are delivered in broken, loose masses just as soon as the larvae are mature, or even ejected before maturity ("aborted") if disturbed. According to recent studies of Dr. Ortmann and Mr. Frierson *Amblema Rafinesque should supplant all previous names for this genus because Amb. costata Raf. is without doubt Unio undulatus Barnes;* hence the following nomenclature:

(1)—*Amblema plicata* (Say) 1817 = *U. plicatus* Say. = *U. hippopea* Lea = *Quadrula plicata hippopaea* Simpson.

(2)—*Amblema plicata costata* (Raf) 1820 = *U. undulatus* Barnes 1823 = *Quadrula undulata* Simpson.

(3)—*Amblema peruviana* (Lamarck) 1819 = *Quadrula plicata* Simpson.

Note that because of the Law of Priority the local form (*plicata* Say) from Lake Erie must be considered unfortunately as the main species, although other than taxonomic reasons would not justify the recognition.

Amblema peruviana (Lamarck)

("Three Ridge," "Big Blue Point").

Pl. XVI,—Figs 35A and B.

1819—*Unio peruviana* Lamarck, An. Sans. Vert., VI, p. 71., Deshayes, An. Sans. Vert., 2d ed., VI, 1835, p. 533; 3d. ed., II, 1839, p. 667.

1900b—*Quadrula plicata* (Say) Simpson, Pr. U. S. Nat. Mus., XII, p. 767.

ANIMAL CHARACTERS:—Since this species is simply an *Amb. rariplicata* (Des.) with very full, high beaks and with identical soft parts, except a small difference of form due to a more elongated shell with deeper umbonal cavities, we would refer our readers to the description of these characters for *rariplicata*. Gravid marsupia have the same structure. Glochidia of *peruviana* are found to be semicircular, spineless, medium size, about as long as high (0.200 x 0.210 mm.)

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell elongate-quadrate with ventral edge rather straight, post-dorsal portion bowed, heavy and greatly inflated anteriorly, rather compressed posteriorly; beaks high, full, incurved, well placed forward, sculpture consisting of concentric lines forming two loops at base of post-umbonal ridge; undulations four to five, coarse, oblique from ventral margin to umbonal region across post-umbonal ridge; costae on slopes of post-dorsal ridge few, broad, shallow and faint; epidermis leathery red to black, rarely yellowish or greenish.

Internal Structures:—Cardinals double in both valves; laterals single in right, double in left valve; umbonal cavities narrowly deep; muscle scars well impressed; nacre marble white with blue and old rose tints posteriorly; deep vein mark on antero-extra pallial border.

Sex	Length		Height		Diameter	Localities.
♂	101	x	64	x	54mm	(Mississippi R., La Grange, Mo.)
♀	112	x	74	x	46 "	(Osage R., Monegaw Springs, Mo.)
♀	48	x	40	x	29 "	(Mississippi R., Hannibal, Mo.)
♂	33	x	28	x	20 "	(Osage R., Osceola, Mo.)

Juveniles of latter measurement very globose; epidermis olivaceous with a reddish brown band in center parallel to growth lines; post umbonal ridge rather prominent; one heavy undulation at post base with two heavy furrows on either side. The very greatly inflated beaks of adult shell is doubtless due to the globular shell of the juveniles.

Miscellaneous Remarks:—*Amblema peruviana* (Lam) is the *Quadrula plicata* (Say) of authors according to the recent decision of Mr. Bryant Walker who is making a special study of original Lamarckian types. Mr. Walker states that Say's type of *plicata* came from Lake Erie and is the form that Lea describes as *hippopaea* and that *peruviana* is a form of the Ohio shell commonly called *plicata* but which is really the *rariplicata* Deshayes. This species should perhaps be reduced to the subspecies, "*Amb. rariplicata peruviana* (Lam); however, because of its difference from *rariplicata* in the possession of full beak and more globular juvenile shell it is left in specific rank. It is found in typical form in the Mississippi north of the Missouri, is scarce but rather typical in the Osage, but is not found at all in the interior north of the Missouri, River.

Amblema rariplicata (Deshayes)

("Ohio Plicata," "Few Ridge," "Big Blue Point.")

Pl. IX,—Fig. 20; Pl. XVI,—Figs. 36A-D.

1830—*Unio rariplicata* Deshayes, Enc. Meth; II, p. 578; An. Sans. Vert., 2d. ed., VI, 1835, p. 533; 3d. ed., II, 1839, p. 667.

ANIMAL CHARACTERS.

Nutritive Structures:—Branchial opening very long with short yellowish papillae; anal slightly crenulate; supra-anal very closely—even decidously—connected to anal by mantle connection; inner gills longer and wider—much wider anteriorly, inner laminae free from the visceral mass; palpi large, connected for about one-third of their length antero-dorsad; except for its brownish gills and palpi the soft parts are a soiled white color.

Reproductive Structures:—All four gills marsupial, ovisacs of inner marsupia more extended transversely, giving the white conglutinates a leaf-shape; ventral edges pointed; glochidia medium size, semi-circular, hinge line long and nearly straight, as long as high, 0.210 mm; conglutinates lanceolate, leaf-like, discharged in broken masses, white in color.

SHELL CHARACTERS.

External Structures:—Shell subquadrate, thick, inflated, posterior end rather rounded; beaks flattened, sculptured concentrically with two or three nodulous structures at base of flattened post-umbonal ridge but disappearing upon the disk; disk with but few shallow undulations, sometimes entirely smooth and running obliquely to position of post umbonal ridge; slopes of post-dorsal ridge rarely costated; epidermis brown or very dark horn color.

Internal Structures:—Cardinals massive, scars deep, umbonal cavity deeply creviced; nacre white with blue, irridescent posterior surface.

Sex	Length		Height		Diameter	Locality.
♂	120	x	72	x	52mm—0.169	(Platte R., Dixon Falls,)
♀	130	x	80	x	62 " —0.230	(" " Garretsburg,)
♀	115	x	80	x	51 " —0.215	(Tarkio R., Craig,)
♂	22	x	20	x	14 " —0.220	(Platte R., Agengy Ford,)

Juvenile shell indicated under last measurement is orbicular in outline, has medium inflation and comparatively high beaks; however, it does not possess the globose character of *peruviana* and its full beaks are soon lost the older it becomes as determined by a good suite.

Miscellaneous Remarks:—*Amb. rariplicata*, as already explained, is the Ohio shell many authors refer to as the *plicatus* of Say, or even as the *perplicatus* of Conrad. It is to be distinguished from the former since that is the Lake Erie form with full beaks; from the latter, however, *rariplicata* is not so easy to distinguish, as its beaks are similar, yet it differs from *perplicata* in being more inflated, with less and shallower plications and with no tendency toward posterior biangulation. *Perplicata*, being more of a southern form, is not found in this state north of the Missouri, while *rariplicata*, a more northern shell, is mostly confined to North Mo., where it is the predominant species of the *Amblemae*, yet it is found occasionally in Central Missouri. Mr. Bryant Walker, who has rescued *raripliplicata* from the synonomy of Simpson's *Quadrula plicata*, has recognized the *North Missouri* "*plicata*" as Deshayes' shell. The habitat of this species is that of muddy bottom with a substratum of limestone, of deep and quiet water and prefers muddy rivers to that of clear creeks. It is found in the Mo. Platte, Grand R., Big Tarkio and occasionally in their larger tributaries. It has never been found in any of the lakes. Its breeding season is very short, having been found gravid only in June.

Amblema perplicata (Conrad)

("Blue-Point," "Three-Ridge," "Round-Lake.")

Pl. XVI. Figs. 37 A and B.

1841—*Unio perplicatus* Conrad, Pr. Ac. N. Sci. Phila., I, p. 19.
1900—*Quadrula perplicata* Simpson, Proc. U. S. Nat. Mus., XXII, p. 767.
1912b—*Credononta perplicata* Ortmann, An. Car. Mus,. VIII, p. 247-248.

SHELL CHARACTERS.

External Structures:—Shell ovate, or obliquely, quadrate, medium in size, moderately inflated, greatest inflation at center of disk; beaks low concentrically sculptured with two or three loops at foot of post-umbonal ridge; posterior end of shell biangulated, 5-6 coarse plications across post-half of shell parallel to antero-postero axis; costae on rounded, post-dorsal ridge few, broad; epidermis black.

Internal Structures:—Cardinals double in both valves; interdentum long and broad; laterals single in right, double in left; muscle scars deeply impressed; nacre white with posterior surface bluish to lavender, irridescent.

Sex	Length		Height		Diameter	Locality
♂	115	x	80	x	48mm	(Osage R., Osceola, Mo.,)
♀	90	x	66	x	46 "	(St. Francis R., Greenville, Mo.,)
♀	83	x	67	x	48 "	(Osage R., Linn Creek, Mo.,)
♂	16	x	14	x	10 "	(" " Warsaw, Mo.)

Many juveniles taken in the Osage average as the above

Warsaw specimen. They are rotund, inflated, epidermis greenish and approach the spherical form of the juvenile *peruviana*. Beaks, even in these young shells, are too eroded to make out the sculptural markings.

MISCELLANEOUS REMARKS:—Since *Amb. perplicata* is a Southern species it is only found in this state in typical form in the south drainage of the Ozark Uplift. Personal collections made by the writer from the St. Francis are found to compare well with typical *perplicata* shells received from Mr. Frierson and taken from type localities. This species is also sparingly found in the Osage where its subspecies, *quintardi* of Cragin is the predominant form of *Amblemae*, and from which it is distinguished by the smaller, more compressed, and much plicated shell of the latter. Under the description of *Amb. rariplicata* the distinguishing features between that species and *perplicata have* been mentioned. At first the inclination was to set this species down in the synonomy of *rariplicata* from general shell features, but the few specific differences in shell as well as that of geographic range are enough to make it distinct. This species is tachytictic, being found gravid by Wilson and Clark (1914, p. 42) from May until July inclusive. The writer examined many throughout June and July to find none gravid; however, its subspecies (*quintardi*) was found gravid during these months and because of these fact some reason was given that this smaller, compressed form was only the female of the larger one, just as seen in case of *Plagiola securis* or *Obovaria retusa*.

Amblema perplicata quintardi (Cragin)

("Little Blue-Point," "Multiplicate.")

Pl. XVI. Figs. 38 A—D.

1887—*Unio quintardii* Cragin, Bull. Wahb. Coll., II, p. 6; Pilsbry, Pr. Ac. N. Sci. Phila., 1892, p. 131, pl. VII, figs, 1-3.

1891—*Unio pilsbryi* Marsh, Nautilus, V. pp. 1 and 2; Nautilus, VII, 1893, pl. I, figs. 7 and 8.

ANIMAL CHARACTERS.

NUTRITIVE CHARACTERS:—Similar to those of the species, having its anal and supra-anal openings often unconnected by mantle edges, free laminar edges of inner gills, palpi mostly connected by their edges, and being colored a dirty white or tan; reproductive structures also rather identical in possessing marsupia occupying all four gills, swollen in the center, when gravid, white when filled with ova, rich brown when charged with glochidia; conglutinates leaf-like, not solid, easily broken; *glochidia semicircular, medium in size, hinge line nearly straight, measuring 0.205 x 0.215 mm.* Dr. Surber kindly indentifies:—"Like *plicata,* but slighlty larger. Easily within the range of variation shown by this species from different localities."

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell obliquely quadrate, small, moderately compressed, rounded before, usually biangulated behind; slightly alated; posterior half of disk profusely plicated, some plicated folds devaricated behind; slopes of post-dorsal ridge with several upcurved costae; beaks low well placed anteriorly, sculptured in concentric fashion with strong ridges upcurved posteriorly; epidermis dark reddish brown to black, without rays.

INTERNAL STRUCTURES:—Cardinals compressed, obliquely grooved, double in both valves, laterals long, slightly curved; beak cavities rather deep; nacre dull white.

Sex	Length	Height	Diameter	Locality
♀	115 x	80 x	48mm	(Osage R., Proctor, Mo.)
♂	80 x	58 x	38 "	(White R., Hollister Mo.)
♀	16 x	9 x	5.5 "	(Osage R., Monegaw Springs, Mo.)
♂	5 x	4 x	3.5 "	(" " Taberville, Mo.)

These last two measurements are among the smallest juvenile shells obtained from the Osage where *quintardi* is so abundant The writer has examined hundreds of them resulting in this general description:—Subovate, slightly longer than high, inflated (yet diameter never equal to height or length), rather bialated; beaks flat (dorsal line over umbonal region curved), sculptured quite well down on disk with three coarse irregular shaped ridges directed post-ventrad having comparatively deep valleys between these bars; epidermis brownish yellow; not byssiferous. Dr. Howard kindly comments: "These juvenile are of the *plicata* group of the Osage the exact relationships of which seems to be undecided."

MISCELLANEOUS REMARKS:—Surely this subspecies is a decided intergrade of the *perplicatus* Conrad and *costata* Rafinesque (= *U. undulatus* Barnes). Mr. Walker has referred this abundant shell for South and Central Missouri to *perplicata variety quintardi*

Cragin while Mr. Frierson would assign it to *undulata variety Pilsbry* Marsh; however, comparisons of these two forms seem to indicate that they are so identical as to assign the latter, through rules of priority, to the synonomy of the former. Dr. Ortmann, who has examined the anatomy as well as the shell characters of this confusing form, considers it as more like *Amblema costata* (Raf.) and suggests the reason why the writer should only find this little "Blue Point" gravid during a six week's survey of the Osage River was that the larger *Amblemae* were probably males of the same species although such sex dimorphism has not been observed in this genus before. Prof. Clark would also assign this form more to the *undulata* (Barnes) than to the *plicata* (Say) group. It has also been considered as very near *undulata variety latecostata* (Lea). Dr. Surber *would not refer it to either group.* One thing is certain, that it is not the typical *Amb. plicata costata* (Raf.) and is far from either *Amb. rariplicata* (Des.) or *peruviana* (Lam). Since there are few intergrades above 'or below *quintardi* and since it is also such an abundant shell for this state and Kansas it is hoped that its assignment here settles it fairly well in this genus. The identical form is common in the White, St. Francis, Black and other southern streams of the Ozarks as well as in the drainage basins of the Osage, Gasconade, Meramec and other streams of the north slope of the Ozark Uplift. However, this sub-species is not found in North Missouri. Hence its habitat is more that of the swift, clear-water streams. Its breeding season is found to be the same as that of its parent species.

Amblema (plicata) costata (Rafinesque)

("Wash-Board," "Three-Ridge," "Blue-Point.")
"Flat-Plicate," "Fluter.")
Pl. XVI, Figs. 39 A—D.

1820—*Amblema costata* Rafinesque, Monograph of Biv. Moll. of R. Ohio.
1823—*Unio undulatus* Barnes, Am. Jour. Sci. and Arts, 1st. ser., VI, p. 120, fig. 2.
1900b—*Quadrula undulata* Simpson, Proc. U. S. Nat. Mus., XXII, p. 769.
1912b—*Crendonta undulata* Ortmann, An. Car. Mus., VIII, pp. 246–247.

ANIMAL CHARACTERS

Nutritive structures, as well as the reproductive, are identical with those of *Amb. rariplicata* in every respect. Even the glochidia are similar, except slightly larger (0.210 x 0.220 mm). Like other members of this genus there is no trace of brilliant colors of the soft parts such as red or orange as seen in the *Fusconaia* or *Alasmidonta.*

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell elliptically subquadrate, compressed; rather thick and heavy umbones, not elevated, slighly inflated, sculptured by five, coarse concentric ridges most pronounced at base of post-umbonal ridge, slighlty alated anteriorly; dorsal ridge high, with four or five upcurved costae; posterior half of shell crossed with five or six oblique undulations with shallow valleys; epidermis reddish brown to yellowish.

INTERNAL STRUCTURE:—Cardinals very heavy, double in both valves; laterals heavy, serrated; interdentum broad, thick; beak cavities deep narrow, crevice-like; muscle scars well impressed, vein markings on extra-antero pallial border; nacre white, often rusty spotted, with blue irridescence at posterior end.

Sex	Length		Height		Diameter	Locality
♂	112	x	73	x	36mm	(Osage R., Schell City, Mo.)
♀	76	x	55	x	32 ”	(Gasconade R., Gascondy, Mo.)
♂	32	x	25	x	15 ”	(Chariton R., Kern, Mo.)

Juvenile shells have coarse concentric undulations upon the umbonal region—especially at base of the post-ridge where they are upcurved; a single broad undulation at the post-ventral position of shell, a slight alation just anterior to the lunule; color of epidermis olivaceous.

MISCELLANEOUS REMARKS:—*Amblema costata* Rafinesque is without question the *Unio undulatus* Barnes, but the trinomial name, *Amb. plicata costata* (Raf.), is used for taxonomic reasons as has already been explained under the remarks on this genus concerning the nomenclature incident to the revival of Rafinesque's "*Amblema.*" This species is very seldom seen in typical form in North Missouri, (never in North-West Missouri) and for that matter, it is also scarce in Central or South Missouri—but its actual forms are most abundant of all the *Naiad* species in this State south of the Missouri River. Most of the students of *Naiades* have returned the results of their studies of the *Missouri Amblemae* indicating a greater prevalence of the "*undulata*" rather than the "*plicata*" form—especially for the swift clear-water mountain streams of the South. By actual surveys of some streams of

Central Missouri, where ecological conditions are the most diverse for the State, the author has been able to observe the same occurrence of the *Amblemae* as noted by Wilson and Clark in the Cumberland River (1914, p. 21) in that the more plicated and less inflated (*undulata*) one will be found in upper courses, while the smoother and more inflated (*plicata*) one is confined to the lower portions of the rivers where there is more mud and a weaker current. On the basis of not only these state-wide observations but also on these as limited to a single river, we would account for the existence of these two opposing types of *Amblema* as due to ecological rather than to genetic causes. However, as juvenile shells of two forms are different their origin would also indicate difference and the matter of their occurrence under certain ecological relations might, after all, be simply one of survival. A careful study of *Amb. costata* shows it to be a summer breeder, beginning in May and closing the latter part of July. As this "*undulata*" group has been understood better taxonomically than the "*plicata*" the geographic distribution of *costata* has also been better determined. Simpson reports it (i. e., his *Q. undulata* (Barnes)) for the Mississippi basin generally; also for the drainage basins of the St. Lawrence, the Red River of the North and the Alabama River. The varieties of this species, however, are reported by many for the area south and west of the Mississippi River known as the "South-West," the fauna of which is included in Central and South Missouri and bounded on the north by the *great faunal barrier, the Missouri River.*

Genus **Megalonaias** Utterback.

(*New Genus.*)

Type, *Unio heros* Say, 1829.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening very large with short papillae; anal and supra-anal also large, almost smooth, separated by short but distinct mantle connection; inner laminae of inner gills partly free from visceral mass or sometimes almost entirely connected; palpi long, enormous; color of soft parts, tan colored, with gills brownish.

REPRODUCTIVE STRUCTURES:—Marsupia occupying all four gills, when gravid enormous, padlike, not so distended at ventral edge; conglutinates, sole-shaped, brown, rather solid; glochidia large, ventral margin obliquely rounded, hinge line long.

SHELL CHARACTERS.

Shell large, ponderous, broadly rhomboid, moderately inflated, post-dorsal ridge alated, sculptured with regular upcurved undulations; post-umbonal ridge broken with coarse plications running more or less parallel with it; beaks rather low, sculptured with coarse double looped-corrugations which extend out as nodules at base of post-ridge and as zigzag ridges all over umbonal region to upper part of disk; epidermis black; cardinals heavy; laterals long and straight; interdentum short; beak cavities narrowly deep; scars very deeply impressed—especially anterior retractor cicatrix; nacre white to pink.

MISCELLANEOUS REMARKS:—Because of the peculiarities of *heros* (Say) as to its animal and shell characters, as well as to its uniqueness of breeding season *it is thought by the author in conference with other students, that this species of Say, very well deserves rank as the type of a new genus.* Although the author has not examined the animal of *boykiniana* Lea, *triumphans* Wright, etc., yet, from shell characters, these allied forms would naturally fall under this new genus, *Megalonaias.* In all probability *crassidens* (Lamarck) [=*trapezoides* (Lea)], which has been grouped very near *heros* (Say), may also deserve a special compartment, according to the recent opinion of Mr. Frierson, who has made special study of this species abundant beds of which are very accessible to him; hence because of the difference of shell characters of *crassidens* from that of *heros* (or from any other *Naiad* shell in the possession of a "ventral scar" as pointed out by Mr. Frierson) this species of Lamarck is not grouped there. Besides *crassidens* is not found in Missouri, neither is *boykiniana*, *triumphans* and other conchologically allied forms of *M. heros and* thus the new genus will safely stand out for this State with its type, (*heros* Say), as the lone representative. *Bariosta* (Raf.) might be the available name for our new genus, if *crassidens* could be found to be congeneric with *heros,* since *Rafinesque* erected his genus for this species which he termed *ponderosus*, but which Mr. Walker, through his close study of Lamarckan types, says is Lamarck's *crassidens* that ante-dates Lea's *trapezoides* as well as Rafinesque's type. From the fact that Crenodonta (Schlüter) falls into the synonomy of *Amblema* (Raf.) because of Simpson's and Ortmann's treatment, (preceded by that of Mörch in 1853) Schülter's name cannot be used. Thus it may be seen why an original name, "*Megalonaias,*" (etymologically embodying a chief character) is herein submitted.

Megalonaias heros (Say)

("Giant Heros," "Washboard.")

Pl. VII, Fig. 16; Pl. VXII, Figs. 48 A—F.

1829—*Unio heros* Say, New Harm. Diss., II, No. 19, p. 291.
1831—*Unio multiplicatus* Lea, Tr. Am. Phil. Soc., IV, p. 70, Pl. IV, fig. 2.
1900b—*Quadrula heros* Simpson, Proc. U. S. Nat. Mus., XXII, p. 770.
1912b—*Crenodonta heros* (Say) Ortmann, An. Car. Mus., VIII., p. 248.

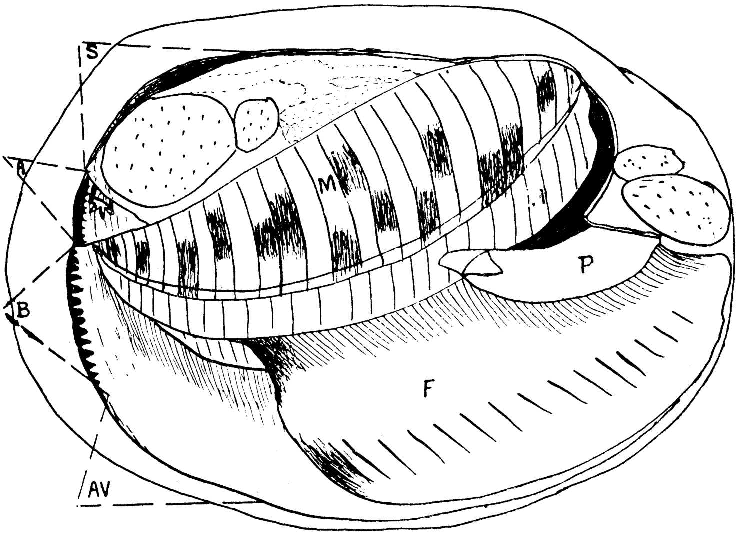
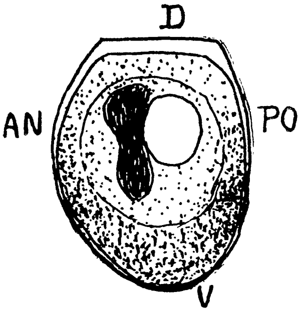


FIG. 2. *Megalonaias heros* (Say). ♀ Diagram of a gravid individual from Platte River, Garretsburg, showing animal characters in left valve. Coll. Jan. 25, 1913. (¾ nat. size.)

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening very large, with comparatively few and small papillae branched at their tips; anal large, very finely dentate on outer edge; supra-anal immense, slightly but distinctly separated from anal by mantle connection; anus tentacled: gills very long and large, inner much wider, inner lamina free from visceral mass for the posterior half or connected except for a slight slit at posterior end or even entirely connected; palpi enormous, connected about nine-tenths of their length antero-dorsad; soft parts mostly a fleshly-tan, branchial edges brown with yellowish papillae in incurrent opening, patch in front of branchial opening chamois-like.

Reproductive Structures:—Marsupia occupying all four gills; when gravid, enormous purplish pads, obtusely rounded at ventral edges; ovisacs simple, undivided, some filled with rusty-brown mucus next to the laminae thus giving the marsupia a splotched appearance; conglutinates shape of an insole, rather solid, usually discharged whole, edges with brownish red pigment, rather thick with no thin transparent portions; glochidia large, post-ventral border obliquely rounded, hinge line long, nearly straight, no spines present, very vital, measures 0.280 x 0.340mm.[1]



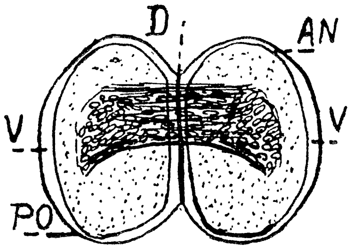


Fig. 3a. Mature glochidium of *M. heros* showing peculiar oblique post-ventral margin from lateral view. (x87—a camera lucida sketch. Left hand figure.)

Fig. 3b Ventral view of open glochidium of *M. heros*. (x87—a camera lucida sketch. Right hand figure.)

SHELL CHARACTERS.

External Structures:—Shell massive, heavy, subrhomboid, post-dorsal ridge rather high slopes of which ribbed with coarse, upcurved, regular undulations originating from umbonal region; post umbonal ridge broken with heavy undulations more or less parallel to post-ridges; beaks rather low and full, sculptured with numerous corrugated or double-looped ridges extending out as prominent nodules on the post-umbonal-looped ridges and zigzag, or WM-shaped, ridges on the umbonal region and upper part of disk; epidermis black, more or less dull color.

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[1] According to Dr. T. Surber, (U. S. B. F. Doc., No. 813, 1915) this glochidium has the greatest variation in size and moreover, he has also found it parasitic upon the gills of the "water dog" (Ne*cturus maculosus*).

INTERNAL STRUCTURES:—Cardinals moderately heavy, double in both valves; laterals very long, not much curved, interdentum short, narrow; beak and branchial cavities rather deep; muscle scar—expecially the progressive impression and that of anterior retractor—very deep; nacre white (often with rusty spots) varying to pink.

Sex	Length		Height		Diameter	Locality
♀	150	x	116	x	56mm	(Platte. R, Dixon Falls.)
♂	153	x	117	x	56 "	(" " Garretsburg.)
♀	100	x	78	x	39 "	(Osage R., Warsaw)
♀	77	x	55	x	25 "	(" " Monegaw Springs)
♂	43	x	27	x	12.5mm	(" " Warsaw)
♀	29	x	19	x	9.5 "	(" " Proctor)

The young and juvenile shells of the last two respective measurements are very profusely sculptured — no part of the external surface being smooth—yet no undulations appear as seen in adult. Beaks low, corrugated; slopes of post-dorsal ridge finely costated; post-ridge with coarse, apiculated or spurred nodules; center and anterior of disk covered with irregularly placed V-shaped ridges and with scattered tubercles; valves extremely flat; nacre sky blue, irridescent. "Work up old shells from the young ones" is Mr. Walker's advice.

MISCELLANEOUS REMARKS:—This most ponderous shell of the *Naiades* is typical in North Missouri and the Mississippi, but the typically massive shell is not found in Central Missouri, and, so far, it is not reported at all for the southern slope of the Ozarks in this state. As a rule, *heros* is only found in the large rivers; however, in this State the type is found in the Missouri Platte—a rather small river, while the medium sized one is found in the largest river of the interior—the Osage—where it assumes the small form perhaps approaching that of *dombeyana* Valenciennes. "Giant *heros*," as this species is often called, is most frequently found in the deepest depressions of mud bottom with a substratum of solid limestone. It hardly ever moves from these situations and perhaps because of this inactivity it accumulates its heavy shell. *Because of the following peculiar characters the* *author sees fit to create a new genus for heros of Say:—*

1.—An unusually heavy shell, with zigzag or V-shaped, sculpturing on upper part of disk and corrugate scupture on beaks.

2.—A tendency of the inner laminae of the inner gills to become more or less united with the visceral mass.

3.—The gravid marsupium an enormously distended pad, colored purplish, or slaty, with reddish splotches here and there parallel to the septa.

4.—Thick, sole-shaped, subsolid conglutinates with rusty-brown margins discharged more or less whole with glochidialying all through the conglutinated mass.

5.—A large, vital glochidium with post-ventral margin obliquely rounded.

6.—Breeding season intermediate, or tachytictic with late season (i. e., bearing glochidia in late winter but being sterile during the summer.)

From *Amblema* this peculiar species must be removed on account of its beak sculpture which is more like that of *Quadrula*—especially of the "*Lachrymosa*" group, yet it is separated from the latter chiefly by its ponderous shell and rugose, V-shaped sculpturing on the umbonal region and upper part of disk. It has been grouped under *Amblema* more on account of the oblique folds on post-half of its shell; however, these plications are, after all, usually disposed differently with respect to the post-umbonal ridge and are not so constant and numerous, nor do they appear so early in the life history of the shell, as in the type for *Amblema.* The special reason that a new genus should be built for *heros* is on the basis of its unique character of soft parts. No other generic type of Unioninae (nor of any of the *Naiades* for that matter) possesses such peculiarities of form, color or size for its marsupium, conglutinate or glochidium; and as to its nutritive structures, none are so eccentric regarding the connection of the inner laminae to its inner gills. Its idiosyncrasy of breeding habits would not only give it a special station, aside from all other *Naiades* so far known, yet this physiological character may account for its oddity morphologically. The author has kept an accurate breeding record of *heros* throughout the year — especially for the winter months when other records have been incomplete—to find it gravid with ova of early embryos in fall and early winter, with late embryos and immature glochidia in midwinter, and with mature larvae in late winter but barren from April to August. Ovulation has been observed for the latter part of August and unfertilized ova have been found in the ovaries August 19th. Sperm having been found within the visceral mass without being accompanied by ova for those individuals that possess gills without the crowded septa of the female proves the sexes distinct and separate and thus disproves the claim of hermaphroditism for this species. It is true that during the height of the breeding season that all individuals found seem to be females but this is the time when there is greater activity among females; hence, they may be more in evidence while the males remain inactive and burrowed from ready accessibility during this season. This fact may account for the so-called hermaphroditism among other species. By laboratory tests the writer has kept the glochidia of this species alive in cold, clear, fresh water exactly thirty days (five time longer than the life of any other mature glochidia submitted to this watch-glass test) after being taken from the mother. This unusual vitality of the larvae is an adaptation to its prolongation of breeding season into late winter when they are discharged into the ice-cold water and left to their fate, for it is the belief of the writer that they are discharged as soon as mature.

Genus **Quadrula** Rafinesque.

1820—*Quadrula* Rafinesque, Ann. Gen. Sci. Phys. Brux., p. 305.
1852—*Rotundaria* Agassiz, Arch. fur, Naturg., p. 48.

(Type, *Obliquaria* (*Quadrula*) *metanevra* (Rafinesque).

ANIMAL CHARACTERS:—Branchial opening large with short arboreal papillae; anal smooth to finely dentate; supra-anal very large, briefly and loosely connected to anal by mantle edges; inner laminae of inner gills free from visceral mass; palpi large, somewhat sickle-shape; color of soft parts not bright, except for brownish gills and palpi, tannish or soiled white; marsupia occupying all four gills, when gravid ovisacs swell moderately in center, ventral edge obtusely pointed; conglutinates white, leaf-like, sometimes divided at distal ends; glochidia small to medium in size, subovate, spineless.

SHELL CHARACTERS:—Shell roundly quadrate, or subrhomboidal, occasionally elongate with moderately high beaks sculptured with 3–4 parallel ridges developed on post ridge to nodules;

disks usually sculptured; epidermis generally dark colored, rayless or with greenish splotched paintings; cardinals heavy, double in both valves, ragged; laterals double in left, single in right; beak cavities deep, compressed or creviced; shells mostly not sexually dimorphic.

MISCELLANEOUS REMARKS:—This genus naturally falls into three groups as follows:—

I. *Pustulosa Group.*

This group is mostly represented in this State by the northern and western form, *Q. pustulosa schoocraftensis* (Lea), and is charasterized by its greater inflation, smoother, larger and more elongated shell with beaks drawn back up more toward the center of the dorsal line; beak sculpture concentric. The actual typical *pustulosa* is rarely, if ever, found in Missouri.

II. "*Lachrymosa*" *Group.*

This is represented in Missouri by *Q. quadrula* (Raf.) (=*lachrymosa* Lea), *nodulata* (Raf.), *fragosa* (Conrad), *aspera* (Lea), *verrucosa* (Raf.), *nobilis* (Conrad) and their intergrades, and may be characterized briefly by a somewhat quadrate or trapezoidal shell, profusely sculptured disk with tubercles arranged in two radiating rows from the beaks to ventral margin divided by a more or less broad radial furrow; beak sculpture double-loop type.

III. *Metanevra Group.*

This third group, is only represented in this state by *Q. metanevra* (Raf.) and *cylindrica* (Say) and is characterized especially by its height and coarsely sculptured umbonal ridge in front of which is a depression but no definite radial furrow and by its peculiarly triangular greenish splotches; beak sculpture double-looped or zigzag type.

The genus *Quadrula* tends toward an unusual intergradation of forms among the above groups in this state and because of this fact the genus might be more properly treated under various sub-genera for this catalogue; however, this treatment may be made unnecessary by the elimination of all the intergrades except those that possess the nearest approach to types. As to soft parts, this genus is identical with *Amblema* but is especially separated from the latter by the negative shell characters of oblique folds across the disk. Simpson, who bases much upon deep beak cavities, as one of the special characters of this genus, includes more under this group, that is, the genera, *Fusconaia, Amblema, Megalonaias, Rotundaria, Plethobasus* and even some species of *Pleurobema.*

Quadrula pustulosa (Lea)[1]

("Warty-Back," "Warty Pigtoe," "Pimple Back.")
Pl. XVII. Figs. 41 A and B.

1831—*Unio pustulosus* Lea, Tr. Am. Phil. Soc., IV, p. 76, pl. VII, fig. 7.
1834—*Unio nodulosus* Say., Am. Conch., VI.
1898—*Quadrula pustulosa* Baker, Moll. Chicago, Pt. I., p. 86, pl. XXV.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening with yellowish plumed tentacles; anal smooth; sura-anal very closely connected—even disconnected—by mantle edge; inner lamina of inner gills free from visceral mass; color of soft parts dingy white; palpi connected for about one-third of their length.

REPRODUCTIVE STRUCTURES:—All four gills entirely marsupial, septa crowded, ovisacs narrow; conglutinates white, leaf-like, broken; glochidia large, semi-elliptical, spineless, hinge line short and evenly curved, measures 0.230 x 0.300mm.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell ovate-quadrate, higher than long, post-umbonal ridge almost horizontal, posterior half pustulate to smooth, dorsal ridge with nodulous costae; beaks protruding anteriorly sculptured concentrically with upcurved ridges posteriorly; epidermis rusty brown with somethimes broad green banded rays diverging from beaks.

INTERNAL STRUCTURES:—Cardinals heavy just under beaks; interdentum broad, upright; laterals straight, at right angles to interdentum; umbonal cavity compressed, deep; nacre white.

Sex	Length		Height		Diameter	Locality
♀	52	x	46	x	32mm	(Miss. R., La. Grange, Mo.)
♂	60	x	60	x	38 "	(" " " " ")
♀	54	x	55	x	34 "	(" " Hannibal, ")

No juvenile shells have been obtained for descriptions; this species is so rare in its typical form for this State that adult shells have been secured with difficulty.

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[1] The name of this species should read *Q. bullata* (Raf.) if we accept Rafinesque's evident description of it in his Monograph (1820, p. 41).

MISCELLANEOUS REMARKS:—Typically this species is a small shell, very upright with beaks protruding extremely anteriorly and with irregularly arranged pustules over its disk. In this latter character it is separated from *Q. nodulata* with which it is often confused; then too *nodulata* is not so rotund. *Pustulosa* is more typically a southern shell while its variety, *schoolcraftensis*, is more of a northern and western form. Its favorite home is clear water and rather swift streams and is associated with *Q. sphaerica, refulgens, mortoni, etc.*,—all of which are not found in Missouri; on the other hand its northern relative (*schoolcraftensis*) is more of a lover of mud bottom and sluggish current. It is strange that this species is not found in South Missouri where its ecological conditions are most favorable; however, it is not at all common anywhere in the great South-west. It is occasionally found in Central Missouri but mostly in varietal forms. The Mississippi River is the only locality for anything like its type. It should be a species of wide distribution since its host distributor is the common crappie (*P. annularis*).

Quadrula pustulosa schoolcraftensis (Lea).

("Warty-Back," "Pimple-Back.")

Pl. XVII. Figs. 42 A—D.

1834—*Unio schoolcraftensis* Lea, Tr. Am. Phil. Soc., V., p. 37, pl. III, fig. 9.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening large, low, with short arboreal papillae; anal obscurely crenulated; supra-anal closely connected to anal but not deciduous; gills tilted at an abrupt angle, inner laminae of inner gills entirely free from visceral mass; palpi unusually long, somewhat curved; except brownish gills and palps the soft parts are dull whitish or tan.

REPRODUCTIVE STRUCTURES:—All four gills marsupial, septa crowded, ventral edges pointed and distended slightly in center when gravid; conglutinates white with thin, transparent spots arranged transversely in rows; glochidia same in form as the parent species, but a little larger (0.235 x 0.320).

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell large, subquadrate, ventral margin gently curved, moderately inflated, thick, heavy; posterior half profusely and irregularly pustulate to smooth; beaks rather high, moderately inflated sculptured concentrically but faintly; epidermis dark straw to chocolate brown in color.

INTERNAL STRUCTURES:—Cardinals heavy, irregular, double in each valve; inter-dentum broad, at right angles to laterals; laterals heavy, double in left, single in right; scars deeply impressed; umbonal cavities compressed by deep crevices; nacre usually white, irridescent especially posteriorly.

Sex	Length		Height		Diameter	Um. ra.	Locality
♀	70	x	58	x	41mm	0.310	(Platte R., Agency, Mo.)
♂	60	x	50	x	30 "	0.300	(Grand R., Darlington, Mo.)
♀	42	x	36	x	26 "	0.295	(Platte R., Claire, Mo.)
♂	17	x	14	x	8 "	0.300	(Grand R., Utica, Mo.)

Since *schoolcraftensis* is one of the greatest occurrence in individuals for this state, the writer has been able to secure the largest collection of its adolescent shells than any of the *Naiades* in Missouri. The above latter measurement is that of *the smallest one but it was without byssi.* Its general outline is more elongated than the mature shell, resembling the adult *Q. quadrula,* post-umbonal ridge more prominent, beaks fuller, almost drawn back to the center of dorsal line, characteristically painted with a bright, broad, fan-shaped, green ray at base of post ridge within the original shell area; beak sculpture indistinct, concentric, broken anteriorly by a radiating furrow directed out on disk.

MISCELLANEOUS REMARKS:—The differences of this variety from the species has already been mentioned under the description of the genus. This form was not admitted by Simpson as a race and is merely referred as "a nearly smooth, compressed form of *pustulosa.*" The varieties of typical *pustulosa,* indeed, are great—especially as to disposition of pustules, etc., but this larger more characteristically quadrate form is so abundant in the north and west, where *pustulosa*-types are rarely found, that it surely deserves a separation into the subspecific, if not specific class. According to the figure and description that triangular variety found in the Ohio River, (that is, Lea's *pernodosa,*) might be a synonym of *schoolcraftensis.* Taking it all in all this subspecies is purely a geographical race, but may pass into normal form in a few places, even in the north and west, such as in the Mississippi River, Illinois and local points where clear water and swift streams are found. *Schoolcraftensis* is a lover of quiet, muddy situations, where it has developed a heavier, less pustulous shell as we note in the ecologic results for some shells of *Amblemae.* This form is reported also for the St. Lawrence basin as well as through all the northern part of the Mississippi Valley, even down into the South-west as far as Kansas and Oklahoma. The writer has been able to keep a good breeding record for this very acessible form for Missouri to find it only gravid through June and July.

Quadrula pustulosa asperata (Lea).

Pl. XVII. Fig. 42 A and B.

1861—*Unio asperatus* Lea, Pr. ac. Nat. Sci. Phila. V, p. 41; Jl. Ac. N. Sci. Phila., V., p. 68. Pl. VII. Fig. 218.

ANIMAL CHARACTERS:—Soft parts have been examined afield and found to be identical with those of the parent species. None were found gravid. All four gills of sterile females were marsupial in character through the test of finding more crowded septa.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Subtrigonal, very upright, higher than long, post-umbonal ridge moderately inflated, dorsal line rather straight, ventral margin abruptly curved, rounded posteriorly, subtruncated anteriorly; beaks well forward and eroded; tubercles few, disposed on upper part of disk; epidermis reddish brown to black.

INTERNAL STRUCTURES:—Identical with those of type, *pustulosa* except perhaps a broader, thinner and more upright interdentum.

Sex	Length		Height		Diameter	Locality
♂	44	x	46	x	28mm	(Osage R., Warsaw, Mo.)
♀	50	x	48	x	32 "	(" " Osceola, Mo.)
♂	46	x	46	x	31 "	(" " Bagnell, Mo.)

MISCELLANEOUS REMARKS:—The form of the above description is of rare occurrence in the Osage River, but still the other form for this state, *schoolcraftensis,* does not occur much oftener in this river. According to Mr. Bryant Walker this is "a western form of *Q. pustulosa* and if it came from the Coosa River, Alabama, it would surely be referred to *Q. asperata* (Lea)." Comparisons to the actual shell from Alabama (Coosa R., Cedar Bluff) shows it to be almost identical both as to external and internal features.

Quadrula quadrula Rafinesque.

("Maple Leaf," "Monkey Face," "Tear Shell.")

Pl. IX., Fig. 19; Pl. XVIII., Fig.s 45 A—F.

1820—*Quadrula quadrula* Rafinesque, An. Gen. Sci. Phys. Brux. p. 305.
1828—*Unio lacrymosus* Lea, Tr. Phil. Soc., III, p. 272, pl. VI, fig. 8.
1831—*Unio asperrimus* Lea, Tr. Am. Phil. Soc., IV, p. 71, pl. V., fig. 3.
1834—*Unio quadrulus* Say, Am. Conch, VI.
1898—*Quadrula lachrymosa* Baker, Moll. Chicago, Pt. I, p. 83, pl. XXV., fig. 1, XII, fig. 2.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening rather large with arboreal papillae; anal slightly crenulate; supra-anal very large closely connected to anal by mantle edges; palpi very long united about two thirds of their length antero-dorsad and heavily vein marked; inner laminae of inner gills free from visceral mass; color of most soft parts tanned flesh color.

REPRODUCTIVE STRUCTURES:—All four gills marsupial; ovisacs wide in middle transversely, ventral positions being divided, giving the white conglutinates a double or triple split appearance, septa thickened at intervals leaving thin transparent elongated spots arranged regularly and transversely in the conglutinates; glochidia not found by writer; Dr. Surber reports it as the smallest of the *Quadrulae;* color of charged marsupia brown; crenulated flap on post-dorsal part of foot; probably sexual in function as only noted in females.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell medium in size, subquadrate to subtrigonal, dorsal ridge more or less alated with costae on slopes undulated or sulcated post-umbonal ridge prominently angled set with coarse tubercles, a valley or radial furrow in front bounded anteriorly by a row of more or less irregularly placed tubercles on center of inflated disk, presenting the appearance of drops of melted wax; epidermis varies from olive green to chest nut brown or even black, in some instances faintly rayed anteriorly and with continuations of green paintings ventrad to some of the tubercles; beaks high, full, furrowed, post-obliquely, sculptured with corrugated, concentric ridges that break into great numbers of small tubercles out on the umbonal region.

INTERNAL STRUCTURES:—Cardinals more or less double in both valves; laterals inclined to double also; umbonal cavities deep and rounded out; nacre white irridescent.

Sex	Length		Height		Diameter		Um. ra.	Locality
♀	115	x	75	x	51mm	x	0.210	(Lake Contrary, St. Joseph, Mo.)
♂	90	x	65	x	48 "	x	0.220	(Platte R., Agency Ford)
♂	86	x	70	x	38 "	x	0.350	(Flat Creek, Sedalia, Mo.)
♀	68	x	54	x	29 "	x	0.325	(Auxvasse R., Fulton, Mo.)
♂	8	x	5	x	4 "	x	0.300	(Grand R., Utica)

The above measurement is the smallest ever taken by the author. It was discovered stranded on a sandbar, where it was traced by its tiny furrowed track in the fine wet sand. Although it had been but few days since its escape from its parasitic life on the fish, yet it had no byssi. It would seem from this, and many other instances, that neither the *Unioninae* nor *Anodontinae* develop byssal threads. Three other juveniles found on this same bar (measuring 11, 13 and 22 millimeters) were also devoid of byssi. It has been the author's experience to find juveniles in companies. The juvenile *quadrula* has the general appearance of a young *fragosa*, having a straw-colored epidermis, very pointed posterior end, deeply sulcated post-ventral position, full rather double-apiculated beaks, with corrugated sculpturing and placed almost in the middle of the dorsal line; tubercles rather folded on anterior umbonal slopes ridged on post-umbonal slopes and finely ribbed on post-dorsal slopes.

MISCELLANEOUS REMARKS:—*Q. quadrula* is represented by many forms in this state—especially in Central Missouri; however, the large, heavy form that ranges from Ohio to Nebraska is rather constant in the drainage basins north of the Missouri River. It is strange that there should be such a depauperization of any of these forms in South Mo. This species is found in Arkansas but rather in the *aspera* form, a small *quadrula* such as mostly seen in the Osage system. Mr. Walker thinks that the key for tracing out the relative ranges of forms might be found in some ancient drainage system, and varieties, such as found in Missouri, ought to help solve the question. The inflated, solid and comparatively smooth variety of *Q. quarula of N*orth Missouri may be referred to Pratt's *Udio lunulatus* (Proc. Dav. Ac. Nat. Sci., I. 1876, p. 167, Pl. XXXI, fig. 1). However, this may simply be the lacustrine form of the type since the fluviatile forms of North

Missouri approach more the typical *quadrula* in being more compressed and more tuberculated. Perhaps the most typical *quadrula* of Missouri is to be found in the geographic center of the state where the flatter, thinner and more "lachrymosed" shell occurs. As in many of the species of these related genera the intergrades are so numerous that we can consider only the most striking ones that may be traced to mere local conditions. The author has found this species to be the most sensitive to discharge its conglutinates immaturely when disturbed from its natural bed and then, too, since conglutinates, spawned in nature, have been examined to find them containing late embryos it is to be inferred that maturity may take place outside. Hence we may account for our difficulty in securing the mature glochidia from the ovisacs of the mother. The writer has examined hundreds of gravid *quadrula* in mid- and late summer only to find every stage of embryonic development except the glochidial. In this respect this species resembles *Q. verrucosa* and the fact that the ovisacs of each contain unusually large quantities of mucus may have some association with their eccentric breeding habits. The breeding season of *Q. quadrula* is from May to August and hence is tacytictic.

Special attention is given here to a deeply sulcated form of this species which occurs rather commonly in our North West Missouri lakes but which may only be a pathologic condition due perhaps, to parasitic attacks upon the mantle glands that build up the shell. Three type shells measure as follows:

Sex	Length		Height		Diameter	Um. ra.	Locality
♂	85	x	70	x	57mm	0.485	(Lake Contrary, St. Joseph, Mo.)
♀	80	x	55	x	54 "	0.450	(" " " " ")
♂	48	x	38	x	40 "	0.435	(" " " " ")

These measurements show an unusual inflation and extraordinary position of the umbones. If this should be a normal form it would deserve specific consideration because of the deep post-dorsal sulcation and also because of the wide, deep radial furrow in front of the prominently angled post-umbonal ridge. However, since Mr. Frierson concurs with the author in the belief that it *may only be "a strange freak" after all* it would be dismissed here with only the reference to its photograph (*Pl. XVIII, Figs. 46 A and B.*)

Quadrula quadrula contraryensis Utterback.

(Round Maple Leaf.)

Pl. XVIII, Fig's 47 A and B.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Same as that of the parent species, except for an absence of a supra-anal opening, a difference in the greater posterior extension of foot and also a general difference of form of soft parts due to a more rounded shape of shell.

REPRODUCTIVE STRUCTURES:—Identical with that of the parent species except for shorter, wider marsupia.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell medium in size, suborbiculate, abruptly curved before, broadly rounded behind with very slight incurvature post-ventrad; well inflated, inclined to globosity; beaks full, high up on dorsal line (as indicated by the large average umboidal ratio of 0.495); tubercles few and small, mostly on umbonal area; post-umbonal ridge rounded, scarcely sculptured; sculpturing on beaks corrugated as on parent species; epidermis olivaceous.

INTERNAL STRUCTURES:—Cardinals different from parent in being reduced to a single, jagged tooth in right valve; somewhat double in left; interdentum long, wide, not so deeply gashed in right valve for the reception of the post-right cardinal; umbonal cavity deep, basin-like; nacre an unblemished white.

Sex	Length	Height	Diameter	Um. ra.	Locality
♂	73.5 x	64.5 x	44.0mm	0.495	(Lake Contrary, St. Joseph, Mo.)
♀	76.0 x	66.0 x	45.0 "	0.500	(" " " " ")
♂	84.0 x	70.0 x	59.0 "	0.483	(" " " " ")
♀	41.0 x	36.0 x	38.0 "	0.520	(" " " " ")

The young shell of the last measurement shows an approach to the parent shell. The comparatively deep sulcation at the post-ventral portion of the shell disappears as seen in a shell series of fairly close connection in ages.

MISCELLANEOUS REMARKS:—The author of this sub-species is satisfied that he has a sufficient collection of this peculiar shell taken from different parts of Lake Contrary, St. Joseph, Missouri, to prove the validity of this form as a variety of that very common, heavy shell, that occurs in the Mississippi Valley, North of the Ohio and also of the Missouri Rivers. The differences in this upright, rounded shell from its parent are stated in the comparative description. Since students of *Naiades* have pronounced it a variety, if found in sufficient numbers, the author concurs by naming it for its type locality, Lake Contrary, St. Joseph, Mo. Wherever found in this lake, the bottom is a soft, marly mud, and the situations are in rather deep water sheltered from wave action. The author has discovered a short period breeding season for *contraryensis*.

Quadrula nodulata Rafinesque.

("Pimple Back," "Warty Back.")

Pl. XVII, Figs. 44 A and B.

1820—*Obliquaria nodulata* Rafinesque, Bivalves of River Ohio, Ann. Gen. Sci. Phys. Brux.
1834—*Unio pustulatus* Lea, Tr. Am. Phil. Soc., p. 79, Pl. VII, fig. 9.
1834—*Unio nodulatus* Say, Am. Conch., VI.

ANIMAL CHARACTERS:—Nutritive structures absolutely identical with those of *Quad. pustulosa* (Lea). The glochidial characters are the same, except a difference in size, the glochidium of *nodulata* being the larger 0.230 x 0.290 mm. However, small differences in *size* may not be considered good distinctions as it is the glochidial *form* that is to be taken into greater account.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell medium in size, solid, suborbicular, inflated, post-dorsal ridge projected; umbones very full, high, incurved bearing three or four small corrugated, concentric ridges; post-umbonal ridge and central part of disk ornamented with two radial rows of small, erect pustules sometimes terminating with half-tubercles at ventral margins; epidermis light tan to dark horn.

INTERNAL STRUCTURES:—Identical with *pustulosa*.

♂	48	x	40	x	30 mm	0.200	(Miss. R.,	Hannibal,	Mo.)	
♀	45	x	38	x	28.5 "	0.250	("	"	"	")
♂	32	x	28	x	23 "	0.210	("	"	"	")

Shell of juvenile subglobose, post-umbonal ridge prominent, post-dorsal ridge short, high; tubercles few in two rows—one on post-ridge—no radial furrow between; beaks very full, sculptured by rather coarse, irregular ridges, extending as tubercles on the disk; epidermis yellowish green with alternate bands of brown and straw color. Interior of shell much like adult except not so broad, nor as upright, nor as long; nacre white with light blue irridescent sheen posteriorly.

MISCELLANEOUS REMARKS:—*Q. nodulata* seems to be only a globular-shaped *Q. quadrula* and is more typically a southern shell; however, it is occasionally met with in the Upper Mississippi, where it is most found in this State. Mr. B. F. Bush collected some miscellaneous shells from the interior of the state and donated them to the United States Museum where some were identified as this species. It is to be distinguished from *Q. pustulosa* especially by two regular radiating rows of widely separated tubercles obliquely arranged from the umbones to the ventral margin on the posterior half of the disk; then, too, it is more inflated, is not so upright, has greater umboidal ratio, has more of an alated dorsal ridge and belongs to the so-called "*Lachrymosa*" Group, whereas, *pustulosa* is a member of the first group of this Genus of which it is the type; hence, the latter is, after all, not even closely allied. However, there is not much difference between these two *Quadrulae* as to the form and size of their larvae, and as to form of adult shell, it lies nearer to the variety, *contraryensis* of *Q. quadrula*. Surber (1913, p. 113) finds this species to be a gill parasite upon the crappie (*Pomoxis annularis*) as an occasional host. As to its breeding habit, it is tachytictic.

Quadrula fragosa (Conrad).

("Hickory Nut Shell.")

Pl. XVIII, Figs. 48 A and B.

1836—*Unio fragosus* Conrad, Monog. of Fresh-water Shells, II, p. 12, Pl. VI., fig. 2.

ANIMAL CHARACTERS.

NUTRITIVE AND REPRODUCTIVE STRUCTURES:—Identical with *Q. quadrula* as far as can be determined, with the scanty supply of material at hand—none of which is in gravid condition. However, Wilson and Clark (1914, pp. 59 and 60) report it with all four gills marsupial, thick, pad-like. Glochidium unknown.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell most quadrate of the *Quad-*

rulae, medium in size, greatly inflated, characteristically sulcated post-ventrad; dorsal ridge prominent, the slopes coarsely costated; post-umbonal ridge prominent and profusely tubercled; radial furrow deep and wide, in front of which another row of rather scattered tubercles extend from the beaks post-ventrad across the disk; epidermis dark yellowish.

INTERNAL STRUCTURES:—Identical with those of *Q. quadrula.*

Sex	Length		Height		Diameter	Locality
♂	63	x	59	x	35mm	(Miss., R. Hannibal, Mo.)
♀	44	x	39	x	18 "	(" " " ")
♂	23	x	16	x	9 "	(102 R., St. Joseph, Mo.)
♂	15.5	x	6.5	x	7 "	(Osage R., Schell City, Mo.)

It may be that the juvenile shell measurement of the last two above is only that of *Q. quadrula* since all juveniles of the latter possess the characteristic sulcation at the post-ventral portion of the shell as well as the profuse costation on the slopes of the post-dorsal ridge; hence, the inferrence the author would draw in asserting that *Q. fragosa* may be an occasional instance of an overgrown shell of *Q. quadrula.*

MISCELLANEOUS REMARKS:—This type of Conrad is of rare occurrence in this State, the Mississippi being the only place where anything like its type may be found with any degree of assurance. Abnormal forms of *fragosa* are seen occasionally in the headwaters of the Osage. Simpson is not certain about the distribution of *fragosa* outside of the Ohio and Tennessee—Cumberland systems. It is mainly distinguished from typical *Q. quadrula* by being more squarely quadrate, more inflated and the upcurved tubercular costae on the rounded post-dorsal ridge being more pronounced. It differs chiefly from *aspera*, (the small *Q. quadrula* form of the Osage) in not being biangulated posteriorly. It has been found to belong to the short period breeders.

Quadrula aspera (Lea).

("Little Rough Shell.")

Pl. XVIII, Figs. 49 A and B.

1831—*Unio asper* Lea, Tr. Am. Phil. Soc., IV, p. 85, pl. IX, fig. 15.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening finely papillose; anal smooth; supra-anal loosely, to deciduously, connected to anal by mantle edges; inner gills much wider (posteriorly), inner laminae of inner gills free from visceral mass; palpi long and broad; soft parts a light tan.

REPRODUCTIVE STRUCTURES:—Marsupia identical with those of *Q. quadrula*. No gravid forms found.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell small, subquadrate, biangulated behind, the biangulation pointed ventrad; post-dorsal ridge costated; post-umbonal ridge prominent, profusely tubercled; radial furrow rather wide and shallow, bounded in front by a rather scattered row of sharp tubercles; epidermis blackish.

INTERNAL STRUCTURES:—Identical with those of *Q. nobilis* which are somewhat peculiar.

Sex	Length		Height		Diameter	Locality
♀	52	x	46	x	29mm	(Osage R., Warsaw, Mo.)
♂	44	x	39	x	27 "	(" " " ")
♀	40	x	38	x	24 "	(" " " ")

MISCELLANEOUS REMARKS.—Although this species has only been found in the Osage basin for this State, yet it is not to say, a very common shell there. So closely related is this small form of *quadrula* to *Q. nobilis* that a good series of shells may reveal it as the young of *nobilis*. *Aspera* has been considered the southern form of *Q. quadrula* and it may be the small multi-tuberculated representative of the South-west which is connected geographically by all forms of intergrades to that large, heavy, smoother representative of the North Mississippi Valley.

Quadrula nobilis (Conrad).

("Big Buck Horn," "Maple Leaf.")

Pl. XIX. Figs. 51 A and B.

1854—*Unio nobilis* Conrad. Jl. Acad. Nat. Sci. Phila., II, p. 297, Pl. XXVII, figs. 2 and 3.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening large with feathered papillae, anal crenulated, supra-anal without mantle-connection to anal—hence both openings virtually one, gills long, rather narrow, inner laminae of inner free only one-half way, palpi enormous connected two-thirds of their length antero-dorsad, color of soft parts tan, for most part, mantle edges at siphonal openings black, gills and parts above darker tan tha parts below.

REPRODUCTIVE STRUCTURES:—Only sterile marsupia observed; all four gills, however, marsupial and same in structure as that of *Q. verrucosa;* glochidium not found.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell roughly pentagonal in general outline, heavy, thick, solid, compressed posteriorly, inflated for one-half of the shell anteriorly, obtusely biangulated behind with truncation obliquely antero-ventrad, broad, shallow, radial furrow, post-umbonal ridge flattened and sculptured with few tubercles, area in front of radial furrow irregularly and coarsely tuberculated, slopes of post-dorsal ridge with low upcurved costae, epidermis dark brown, growth lines coarse.

INTERNAL STRUCTURES:—Cardinals and laterals both distinctly doubled in the two valves, interdentum short, wide, cut away in right valve for the post-left cardinal, anterior adductor muscle scars usually drawn to the front, nacre milky white.

Sex	Length	Height	Diameter	Locality
♀	120 x	88 x	57mm	(Marais des Cygnes R., Rich Hill,)
♂	80 x	56 x	30 ”	(Osage R., Greenwell Ford)
♀	56 x	46 x	27.5mm	(” ” ” ”)

No juveniles were obtained. The last measurement, is that of the smallest in the writer's collection, but shows no real juvenile characrters, and is more like *Q. aspera* except for its difference in posterior biangulation and also in its tuberculation.

MISCELLANEOUS REMARKS:—Simpson (1900b, p. 776) puts *Q. nobilis* down in the synonomy of *aspera,* but later refers it to *Q. verrucosa.* However, from studies of its peculiar anatomy and internal shell structures it may come very near to *verrucosa.* This is a rather common species for the Osage where it reaches a larger, heavier growth of shell than is ever attained by *verrucosa.* It is also a broader, shorter shell with great solidity and inflation anteriorly and also greater compression posteriorly. *Nobilis* is reported by Isely (1914, p. 4) for the lower Neosho basin. It likewise appears occasionally in this same drainiage for Missouri and is also found in the Grand River of North Missouri. Like *R. tuberculata* (Raf.), *nobilis* may be said to have no true supra-anal opening due to its lack of mantle connection between the anal and supra-anal region. This lack of mantle connection is a constant character in this species, whereas this deciduity is inconstant among other *Quadrulae*. The fact of its partial union of the inner laminae of the inner gills with the visceral mass is also a departure from the general characters of this genus and a step toward the modern arrangement. In this latter character *nobilis* is somewhat like *Megalonaias heros*. From the fact that females were found sterile all through early and mid summer, it may be inferred that its breeding season is very short and begins early in spring, or like, *heros* begins late in the season. Later investigations may relate this species more closely to *Megalonaias* for the physiological reasons as well as for the morphological.

Quadrula verrucosa Rafinesque.

("Deer Horn," "Buck Horn.")

Pl. XIX, Figs. 50 A—D.

1820—*Unio* (*Obliquaria*) *verrusoca* Rafinesque, Ann. Gen. Phys. Brux.
1823—*Unio tuberculata* Barnes, Am. Jl. Sci., VI, p. 125, Pl. VII, figs., 8a, 8b.
1899—*Tritogonia tuberculata* Simpson, Pr. U. S. Nat. Mus., p. 608.
1912a—*Quadrula tuberculata* Ortmann, Ann. Car., Mus., p. 254.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening densely set with arboreal papillae, anal crenulated, supra-anal smooth, very large, slightly (even deciduously) connected to anal by mantle edges; gills very long, comparatively narrow, inner broader, inner lamina of inner gills connected to visceral mass except for a short distance anteriorly; palpi very long, connected antero-dorsad for a little more than half their length; color of soft parts, mostly solid white, gills brown.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell rather large, elongate, roughly trapezoid; male shell shorter, more pointed posteriorly and angled dorsad; female shell much longer, biangulated post-ventrad; disk profusely tuberculated, the coarser tubercles located ventrad; post-umbonal ridge prominent and nodulated; slopes of post-dorsal ridge faintly costated, beaks rather small, apiculated, sculptured with double-looped, zigzag markings that extend out on the disk; epidermis chestnut brown to dark horn color.

INTERNAL STRUCTURES:—Cardinals heavy, ragged, double in left usually single in right; laterals long, rather straight and heavy; beak cavities deep; nacre marble white, occasionly pink, irridescent posteriorly

Sex	Length		Width		Diameter	Locality
♀	169	x	88	x	48	(Grand R., Darlington)
♂	150	x	78	x	44	(Platte R., Agency Ford)
♂	110	x	50	x	30	(Osage R., Warsaw)
	54	x	30	x	15	(White R., Hollister)

No juveniles obtained. The last measurement is that of the youngest *verrucosa* obtanied. Its beak sculpture and disk are entirely sculptured with nodules and tubercules. The slope of the post-dorsal ridge are sculptured with three or four coarse, costated undulations and with numerous fine costae arranged dorsad; shell very greatly compressed; nacre bluish.

MISCELLANEOUS REMARKS:—*Q. verrucosa* is the most peculiar species of its genus on account of *the sexual dimorphism of its shell.* For this reason especially, Simpson created a special genus (*Tritogonia*) for it. Some students are inclined to think that *Tritogonia* deserves sub-generic rank at any rate, because of its morphological departure form the typical *Quadrula* shell. Its soft parts, however, are so identical with those of the typical *Quadrula* that there is no reason for its groupings with any other genus. Even though the form of the shell may be differnt, yet its conchological parts correlate with those of other *Quadrulae*. Although Rafinesque's figure of this species is abomnable, yet an unbiased study of it, together with that of his good description, would give preference for the adoption of his *verrucosa* over that of Barnes' *tuberculata*. Like *Q. quadrula*, its breeding season is about as eccentric, in that the mature glochidia are not retained in the marsupia for any length of time; hence this accounts for the great difficulty of securing its larvae for study. Surber was fortunate in securing specimens with ripe glochidia June 10th. The writer would judge from this record and that of his own (i. e., sterility for the Fall and Winter months) that this species is tachytictic. *Vercucosa* has the widest distribution for this State: however, it varies somewhat in size, inflation, disk sculpture, nacre-color for the different sections of the State; e. g., the pink-nacred ones are exclusively confined to the Southern Missouri streams.

Quadrula metanevra (Rafinesque).

("Maple Leaf," "Monkey-face" "Stranger.")

Pl. XIX, Figs. 53 A and B.

1820—*Obliquaria* (*Quadrula*) *metanevra* Rafinesque, Ann. Gen. Sci. Brux., V, p. 305. Pl. LXXXI, fig. 15 and 16.

1834—*Unio metanevrus* Say, Am. Conch., VI.

1900b—*Quadrula metanevra* (Raf.) Simpson, Proc. U. S. Nat. Mus., XXII, p. 774.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening large with short feathered papillae; anal smooth to finely dentate; supra-anal very long, open, closely connected by mantle edges to anal; gills short and wide the anterior connection of outer to mantle far removed from base of palpi, inner laminae of inner gills free from visceral mass; palpi long, pointed, connected for one-third of their length; color of soft parts mostly a dingy white, the only different color being a straw-yellow of the mantle margin at branchial opening.

REPRODUCTIVE STRUCTURES:--All four gills marsupial, septa and water tubes (ovisacs) well developed, when gravid, marsupia moderately swollen, ventral margins sharpened; conglutinates white, broken, compressed, leak-like; glochidia average 0.180 x 0.190mm., semi-elliptical, ventral margin rounded, spineless, medium size, hinge line undulate.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell roughly pentagonal, alated, deeply furrowed between dorsal and post-umbonal ridges to emarginated post-dorsal portion; shallow radial furrow just in front of coarsely tuberculated and prominent post-umbonal ridge; disk with smaller, tear-like tubercles scattered all over; beaks rather apiculated, sculptured by coarse corrugations extending out on disk; epidermis brownish yellow, pointed by irregular, downward pointing, green, chevron-like splotches.

INTERNAL STRUCTURES:—Cardinals doubled in both valves; laterals also doubled, right faintly so; beak cavities deep, compressed; nacre pure white to pale pink.

Sex	Length		Height		Diameter	Locality
♀	65	x	60	x	39mm	(Miss. R., Hannibal)
♂	85	x	55	x	36 "	(Meramec R., Fern Glen)
♂	54	x	50	x	25 "	(Osage R., Proctor)
♀	55	x	48	x	30 "	(" " Greenwell Ford)
♀	14	x	11	x	6.5mm	(" " Osceola)

Juvenile shell with three nodulous expansions on post-umbonal ridge, deep furrows between nodules; ligament bright pea green; epidermis straw-color; slopes of dorsal ridge slightly ribbed; beaks high upon dorsal line; posterior peculiarly roundly lipped for the branchial opening.

MISCELLANEOUS REMARKS:—The shell characters of *metanevra*, typical of the whole genus, are highly emphasized. The enormous supra-anal opening and yellow mantle border at the siphonal opening are characteristic of its soft-parts. This species is well represented in Central Missouri and in the Des Moines and Mississippi, but is seldom found in North or South Missouri. The writer has only found it in the Grand River of North Missouri and while he himself has not found it in South Missouri, yet Mr. Walker has it in his collection from Black River, Popular Bluff, Missouri. Simpson (1900b p. 774) reports it for general distribution throughout the Mississippi drainage area except its southern portion, extending to the Tennessee and Arkansas rivers. Its favorite habitat is sandy or gravelly shoals and, as its shell responds to its surroundings, the general form of shell may vary so much as to make it appear as a different species, or sub-species. Its breeding season is found to be tachytictic.

Quadrula metanevra wardii (Lea).

("Monkeyface.")

Not Figured.

1861—*Unio wardii* Lea. Pr. Ac. N. Sci. Phila., V, p. 372; Jl. A. C. N. Sci. Phila., V., p. 187, Pl. XXIV, fig. 257.

ANIMAL CHARACTERS:—Identical with those of its parent species.

SHELL CHARACTERS.

EXTERNAL CHARACTERS:—Shell more elongated than its species, comparatively smooth, heavier, more solid, post-umbonal ridge with an expansion just before reaching basal line; otherwise its external and internal shell structures are identical with those of *Q. metanevra.*

Sex	Length	Height	Diameter	Locality
♀	86 x	70 x	54mm	(Des Moines R., Dumas)

MISCELLANEOUS REMARKS:—Shells from the type lot, sent to the National Museum and now under the label of variety *wardii* of Lea, and numbered 134,639, are now in the writer's collection through the kindness of the collector, B. F. Bush. However, it is the opinion of the writer that this form may not deserve a name since *metanevra* is subject to so many intergrades due to local conditions. The above comparative description shows its departure not far from type, besides the form is inconstant.

Quadrula cylindrica (Say).

("Razor Handle,""Cob Shell," "Rabbit's Foot,"
"Spectacle Case.")

Pl. XIX, Figs. 52A and B.

1816—*Unio cylindricus* Say. Nich. Ency., II, Pl. IV, fig. 3.
1819—*Unio naviformis* Lamarck, An. Sans., Vert. VI, p. 75.
1900b—*Quadrula cylindrica* (Say) Simpson, Proc. U. S. Nat. Mus., XXII, p. 773.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening moderately large with brownish yellow tentacles; anal finely papillose; supra-anal briefly connected to anal by mantle edge; gills very long and narrow, outer more narrow anteriorly, inner laminae free from visceral mass; palpi long, narrow connected one-third of their length antero-dorsad; color of soft parts peculiar, foot with orange back-ground striped in black, visceral mass uniorange, mantles with black pigment especially along the margins at siphonal openings.

REPRODUCTIVE STRUCTURES:—Only sterile marsupia found, these with normal structures of *Quadrula*. Glochidia unknown.

SHELL CHARACTERS.

EXTERNAL STRUCTURES:—Shell rectangular-elongate, length three times the height, dorsal posterior ridge, long, high, slightly costated; wide behind, abruptly rounded before; post-umbonal ridge high, hummocky and pustulate; umbones low, somewhat sharp pointed, incurved, sculptured by corrugated ridges breaking into tubercles out on disk; epidermis dark straw painted (as in *metanevra*) with green toothed splotches pointed ventrad.

INTERNAL STRUCTURES:—Cardinals double in both valves, serrated and irregular; laterals slightly double and very long; interdentum unusually long; nacre white subject to stain.

Sex	Length		Height		Diameter	Um. ra.	Locality.
♂	105	x	40	x	34	0.190	(White R., Hollister—)
♀	108	x	40	x	39	0.190	(Center Cr., Webb City)
♀	75	x	30	x	28	0.200	(St. Francis, Greenville)
♂	70	x	28	x	26	0.210	(Black R., Williamsville)

MISCELLANEOUS REMARKS;—It is regretted that the description of this interesting species still remains incomplete, from the fact that no juveniles, nor mature individuals bearing ripe glochidia, are found yet. *Cylindrica* is distinctly a southern species and is not found in North or even Central Missouri and is never found in the Mississippi north of the mouth of the Missouri. It is a rather common shell for the White and St. Francis Rivers and from deposits of shells in Indian graves it has been found to be abundant in the streams of Southwest Missouri where it is now extinct. Perhaps the identity of *cylindrica* is one of the most evident because of its unique shell and yet it may well be described as an extremely elongated *Q. metanevra*. The breeding record kept by the writer is early embryos August 14 and sterile maruspia August 29; Wilson and Clark (1911, p. 42) record its gravidity for June 17 and July 27 but do not indicate the embryonic stages.

Genus **Rotundaria** Rafinesque.

(Type *Obliquaria* [*Rotundaria*] *tuberculata* Rafinesque.)

1820—*Rotundaria* Rafinesque, Monograph of Bivalve Shells of River Ohio, Ann. Gen. Sci. Phys. Brux.

1900b—*Rotundaria* (Raf.) Simpson, Proc. U. S. Nat. Mus., XXII, p. 794 (as subgenus)

ANIMAL CHARACTERS:—Siphonal openings peculiar in possessing no true supra-anal openings; gills short wide, inner much wider centrally, inner laminae free from visceral mass; palpi connected about two-thirds of their length antero-dorsad, acuminate postero-ventrad; only outer gills marsupial water tubes more crowded than in non-marsuplal gills when gravid marsupia not much distended length-wise through center, ventral edge pointed; conglutinates white, broken, rather narrowly leaf-like, or lanceloate; glochidia semi-elliptical, spineless, large, hinge line short and undulate.

SHELL CHARACTERS:—Shell rotund, disk sculptured for two-thirds of posterior part with irregularly placed tubercles, slopes of post-dorsal ridge regularly costated, some costae somewhat parallel to umbonal ridge behind; beaks well placed anteriorly, sculptured profusely with concentrically zigzag lines across two obliquely posterior ridges being coarser in the valley between; nacre purple; cardinals heavy, double in left, more inclined to be single in right; beak cavities deep antero-postero, narrow diametrically, wide vertically.

MISCELLANEOUS REMARKS:—This genus is unique for its absence of supra-anal opening, for its limitation of marsupia to the outer gills and for its peculiar shell structure in the presence of a well developed sulcus at the post-dorsal part and in its remarable beak sculpture. The two species of this Genus are most typically represented in the Mississippi of this State, but are found to be more intermediate in form for Central and South Missouri. In the Gasconade and Osage basins these forms grade into those that may be referred to *Plethobasus cooperianus* as far as shell structure is concerned.

Rotundaria tuberculata (Rafinesque).

("Purple Warty Back," "Red Nigger Head."))

Pl. XIX, Figs. 54 A and B; Pl. I, Figs. 1—4.

1820—*Obliquaria* (*Rotundaria*) *tuberculata* Rafinesque, Ann. Gen. Sc. Brux., V., p. 103.

1898—*Quadrula verrucosa* Baker, Moll, Chicago, Pt. I, p. 85, pl. XXIII.

1900b—*Quadrula tuberculata* Simpson, Proc. U. S. Nat. Mus., XXII. p. 795.

1912b—*Rotundaria tuberculata* (Raf.) Ortmann, An. Car. Mus., VIII, pp. 258–259.

ANIMAL CHARACTERS.

NUTRITIVE STRUCTURES:—Branchial opening very large with few short simple papillae; anal as large as branchial with still shorter papillae; rectum large, visible, anus slightly tentacled; gills wide, short, tilted at abrupt angle, inner much wider, inner laminae free from visceral mass; palpi connected over half of their length antero-dorsad, pointed postero-ventrad; soft parts dingy wihite, for most part, gills dark brown black posteriorly, foot dark tan.

REPRODUCTIVE STRUCTURES:—Only outer gills marsupial, septa closely crowded, when charged distended very little even in median-longitudinal line, ventral edge not blunt, ovisacs rather narrow; conglutinates white, narrowly lanceolate, not solid; *glochidia large, spineless, ventral margin rounded, hinge line short, straight, or nearly so, measures 0.267 x 0.325mm.*, collected by author, Aug. 11, 1913, Osage River, Bagnell, Missouri.

SHELL CHARACTERS.

External Structures:—Shell oval quadrate, medium in size, compressed, heavy, thick, rounded in front, usually emarginated post-dorsad with radial furrow from this sulcation to beaks, dorsal ridge rather high with upcurved costae; post-umbonal ridge rather rounded; posterior half of shell profusely sculptured with coarse pustules and fine tubercles; umbones low, pitched considerable anteriorly, sculptured with numerous, heavy, wavy or corrugated ridges which extend down on upper part of disk; epidermis brownish red to black.

Internal Structures:—Cardinals double in left, rather tripartite in right valve; laterals double in both valves, lower right lateral rudimentary, scars deep; beak cavities very deep antero-postero, narrow diametrically, wide vertically, nacre rich purple, with part within the mantle line a lighter shade, sometimes whole nacreous surface faded to whitish with pinkish teeth.

Sex	Length	Height	Diameter	U. ra.	Locality.
♀	80 x	60 x	37mm	0.120	(Meramec R., Fern Glen)
♂	64 x	54 x	27 "	0.135	(Gasconade R., Gascondy)
♀	63 x	62 x	33 "	0.128	(Osage R., Schell City)

The last measurement is that of the smallest juvenile out of a collection of 156 collected in a space twenty-feet square in the White River. This place was a quiet retreat of shallow water with a thin coating of mud over a substratum of limestone.

Miscellaneous Remarks:—The peculiar shell characters of this species in being suborbicular, heavy, with low corrugated beaks and the unique anatomical characters in possessing no supra-anal opening and only outer gills as marsupial are features especially to be noted. Its distribution in this state is peculiar in that it is not found at all in the interior northern drainage of the Mississippi River, and is confined in its typical form more in the drainage of the south slope of the Ozarks and in the Missouri portion of the Mississippi while it occurs by intergrades in the southern drainage of the Missouri River. Simpson reports it for the Mississippi drainage generally. A three hundred mile survey of the Osage River, beginning at the headwaters, reveals the shell of this species in all its external form and nacre-color extending to *granifera* and even including *Pleth. cooperianus*. Variation in nacre-color for this species is remarkable; however, this deviation from the unipurple nacre of the type may be due to local reaction since it is most noticed in the Osage below the region of medicinal springs. Its favorable habitat is that of rocky shoals, but is occasionally found in deep, quiet water with mud bottom where it acquires a smoother, heavier and less inflated shell. The writer has had the good fortune to secure, *for the first time, several individuals gravid with mature glochidia.* The larva is found to be somewhat smaller than that of *R. granifera* and with hinge line shorter and straighter; as to form, and even as to size, it is hardly distinguishable from *granifera* when allowance is made for variation in a large series. This glochidium is *figured and described here for the first time* (See *Plate I, Fig. 4*). It is observed by the writer to be gravid from June until the middle of August, bearing ripe glochidia mostly about the middle of July. It is decidedly a short period breeder.

(To be continued.)

ENUMERANTUR PLANTAE DAKOTAE SEPTENTRIONALIS VASCULARES.—I.

ENUMERAVIT J. LUNELL.

The Vascular Plants of North Dakota.—I.

With Notes by J. Lunell.

INTRODUCTORY.

The statements and data furnished in the following series of papers are derived substantially from a twofold origin: (1) *My own herbarium*, a part of which contains the visible results of my wanderings in this state during the years of 1889 to 1914 (except 1897 and 1903, when field work in the state of Oregon and in Europe attracted my exclusive attention); and (2) *My Panama-Pacific Exposition Herbarium of North Dakota*, which contains a rich supply of its own habitational informations, and

EXPLANATION OF PLATES.

Plates I—IV, VII and VIII are intended to be a further elucidation of the text, especially as to shell structures. Plates III and IV are comparative representations of the beak sculpture and marsupial characters of the three Sub-Families. Plates V and VI are careful drawings of new species described and figured for the first time. Plate IX shows physiological relations while Plates X—XIV show the ecologic. Plates XV—XXVIII are photographs of shells representing about one-half natural size, arranged in progressive order of classification, and, in most cases, the shell structures of the exterior are shown by the left valve and of the interior by the right.

EXPLANATION OF PLATE I.

Fig. 1.—External structure of left valve of *Rotundaria tuberculata* Rafinesque, ♀ (Nat. size).

1.—Anterior end.
2.—Posterior end.
3.—Ventral side.
4.—Dorsal side.
5.—Antero-ventral side.
6.—Antero-dorsal side.
7.—Post-dorsal section.
8.—Post-ventral section.
9.—Nodule.
10.—Tubercle.—Umbonal region.
11.—Center of disk.
12.—Lunule.
13.—Beak, or umbone.
14.—Ala, or dorsal ridge.
15.—Costae.—Dorsal slope.
16.—Post-umbonal ridge.
17.—Rest lines of growth.
18.—Minor lines of growth.

Fig. 2.—Internal structure of right vavel of *R. tuberculata* (Raf.) ♀ (Nat. size.)

1.—Epidermis.
2.—Outer nacreous zone.
3.—Middle nacreous zone.
4.—Inner nacreous zone.
5.—Vein marks.
6.—Retractor muscle scar.
7.—Post, add. mus. scar.
8.—Anterior adductor muscle scar.
9.—Branchial cavity.
10.—Lunular hinge.
11.—Cardinal tooth.
12.—Hinge tooth.
13.—Interdentum.
14.—Hinge ligament.
15.—Beak cavitiy.
16.—Ala, or wing.
17.—Beak showing sculpture.

Fig. 3a.—Lateral view of juvenile *R. tuberculata* showing sculpturing of beak extending out on disk. (Nat. size).

Fig. 3b.—Dorsal view of juvenile *R. tuberculata* showing beak sculpture. (Nat. size.)

Fig. 4.—Right side of closed glochidium (X87) of *R. tuberculata* (*nov. glochidium*) showing:—

1.—Anterior end.
2.—Posterior end.
3.—Dorsal, or hinge line.
4.—Ventral margin.
5.—Center of disk.
6.—Adductor muscle.
7.—Posterior adductor.
8.—Pericardial area.

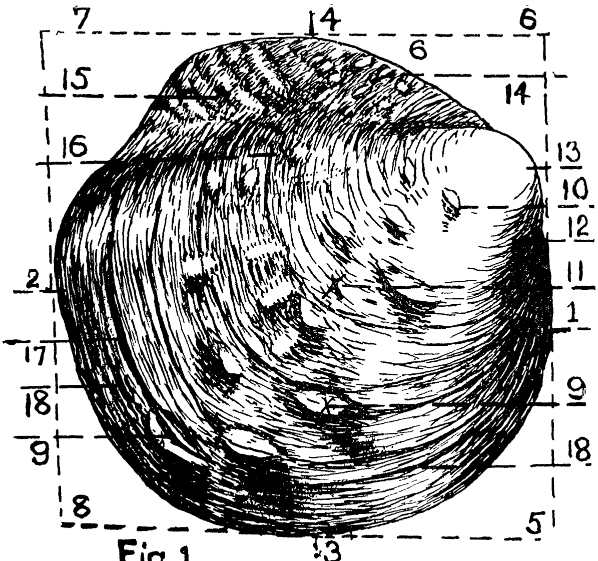


Fig. 1

Fig. 3a

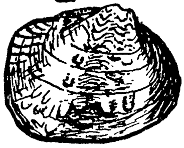
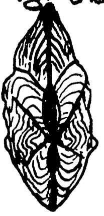


Fig. 3b



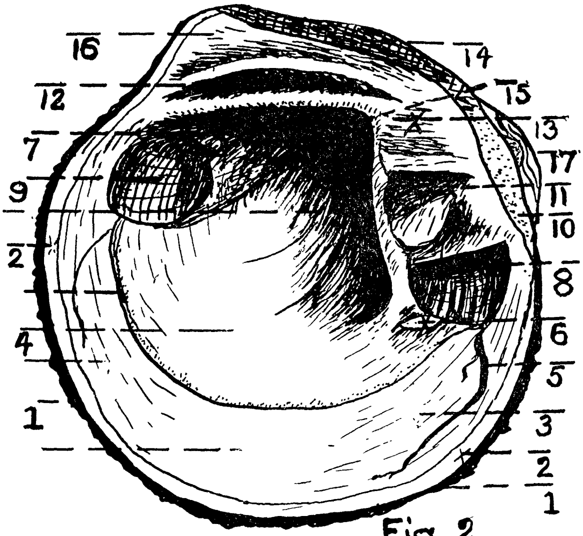


Fig. 2.

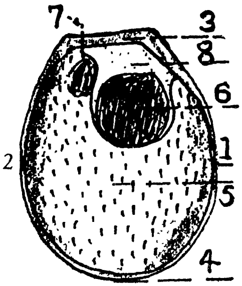


Fig. 4.

PLATE I. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE II.

Fig. 5a.—External structures of left valve of *Plagiola securis* (Lea)—Male shell reduced one-fourth from natural adult size.

1.—Extreme ventral point.
2.—Extreme anterior point.
3.—Extreme posterior point.
1–2.—Antero-ventral section.
1–3.—Post-ventral section.
2–4.—Antero-dorsal section.
3–4.—Post-dorsal section.
5.—Minor lines of growth.
6.—Rest lines of growth.
7.—Lunule.
8.—Beak or umbone.
9.—Post-dorsal truncation.
10.—Broken rays.

Fig. 5b.—Internal view of right valve of *P. securis.* ♂ Same reduction as in Fig. 5a.

Fig. 6a.—External view of left valve of *P. securis.* Female shell reduced one-fourth from natural adult size. Same age as adult. Comparison to male shell of Fig. 5a. denoted by dotted outline.

Fig. 6b.—Internal structures of right valve of P. *securis.* ♀. Same reduction as in Fig. 6a.

1.—Ventral margin.
2.—Epidermis.
3.—Mantle line.
4.—Vein marks.
5.—Ant. retractor mus. scar.
6.—Ant. adductor mus. scar.
7.—Cardinal tooth.
8.—Beak cavity.
9.—Interdentum.
10.—Beak.
11.—Hinge ligament.
12.—Hinge tooth.
13.—Protractor mus. scar.
14.—Post add. mus. scar.

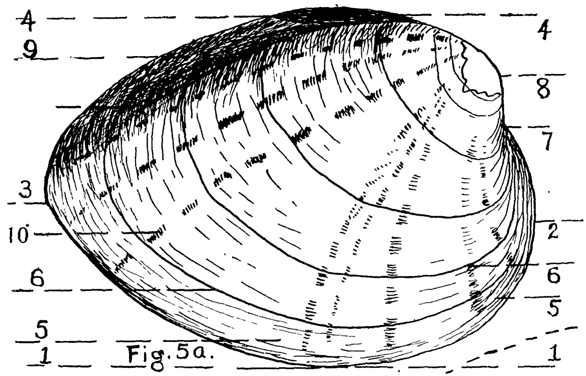


Fig. 5a.

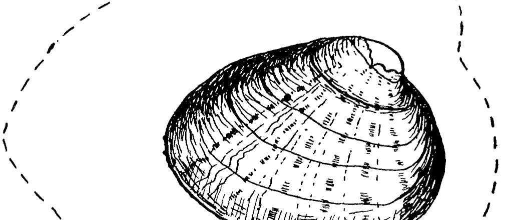


Fig. 6a.

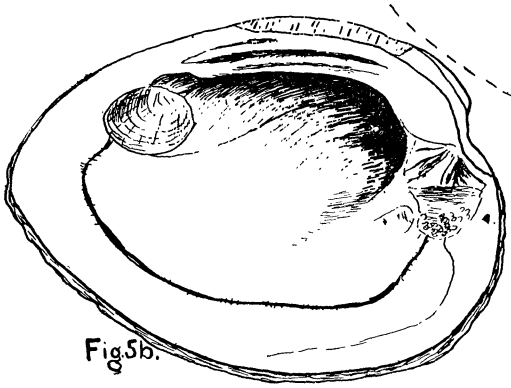


Fig. 5b.

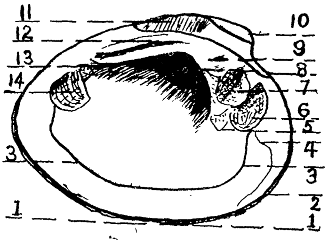


Fig. 6b.

PLATE II. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE III.

Fig. 7a.—External structures of *Anodontoides ferussacianus* (Lea). ♀ (Nat. size).

1.—Ventral extremity.
2.—Dorsal extremity.
3.—Anterior extremity.
4.—Posterior extremity.
5.—Minor lines of growth.
6.—Rest lines of growth.
7.—Beak.
8.—Post-dorsal ridge.
9.—Post-umbonal ridge.

Fig. 7b.—Internal structures of shell of *A. ferussacianus*. ♀.

1.—Ventral extremity.
2.—Dorsal extremity.
3.—Anterior extremity.
4.—Posterior extremity.
5.—Rest lines of growth showing through shell.
6.—Mantle line.
7.—Ant. add. scar.
8.—Post. add. scar.
9.—Beak cavity.
10.—Apex of beak.

Fig. 8a.—Dorsal view of *A. ferussacianus* shell showing *Anodontine* beak sculpture.

Fig. 8b.—Dorsal view of *P. coccineum* shell showing *Unionine* beak sculpture.

Fig. 8c.—Dorsal view of E. (*C.*) *parva* shell showing *Lampsiline* beak sculpture.

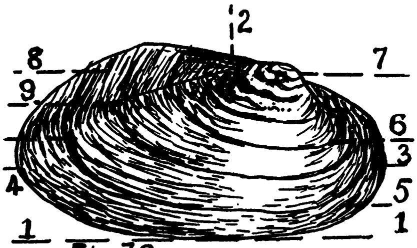


Fig. 7a

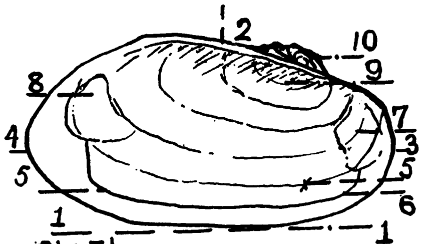


Fig. 7b.

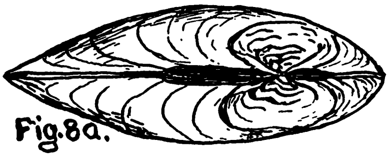


Fig. 8a.

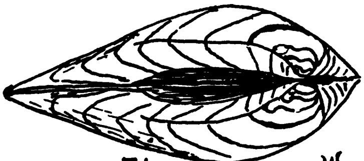


Fig. 8b.

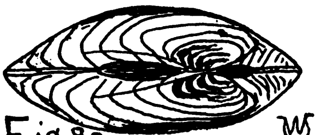


Fig. 8c.

PLATE III. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE IV.

Fig. 9a.—Right gills of *Fusconaia undata trigonoides* Frierson, showing *both marsupial,*— a *Unionine* character.

Fig. 9b.—Diagrammatic, vertical section of a *Unionine* ovisac at ventral margin.

Fig. 10a.—Right gills of *Lastena suborbiculata* (Say) showing entire *outer one marsupial,*—an *Anodontine* character.

Fig. 10b.—Diagram of *Anodontine ovisac* showing lateral water tubes as provision for aeration of embryos.

Fig. 11a.—Right gills of *Proptera alata* (Say) showing only *posterior portion of outer one marsupial,*—a *Lampsiline* character.

Fig. 11b.—Diagram of *Lampsiline* ovisac, showing rupture of ventral edge to allow escape of glochidia.

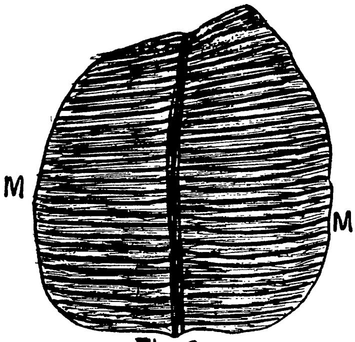


Fig. 9a

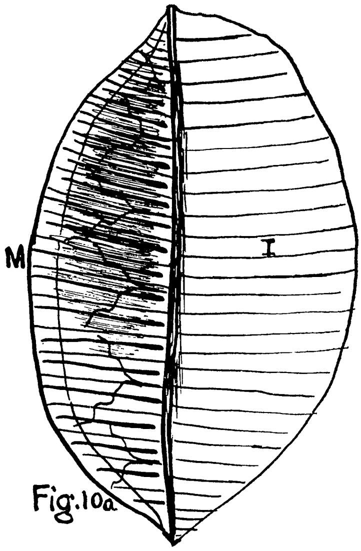


Fig. 10a

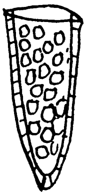


Fig. 9b

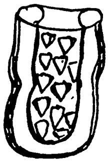


Fig. 10b

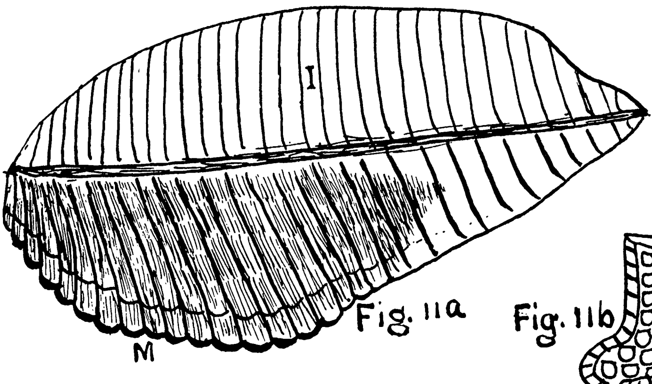


Fig. 11a

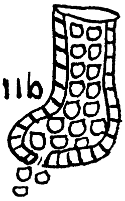


Fig. 11b

PLATE IV. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE V.

(Drawings by G. T. Kline.)

Fig. 12a.—External view of left valve of a new species, *Pleurobema Utterbackii* Frierson. ♂ (Nat. size.)

Fig. 12b.—Internal view of right valve of *P. Utterbacki.* ♀

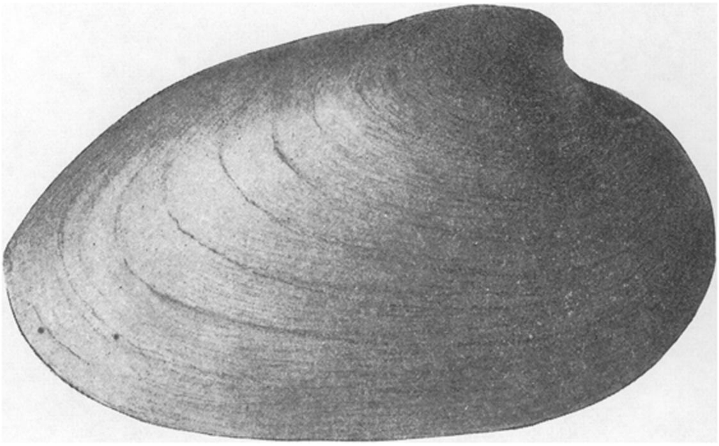


Fig. 12a.

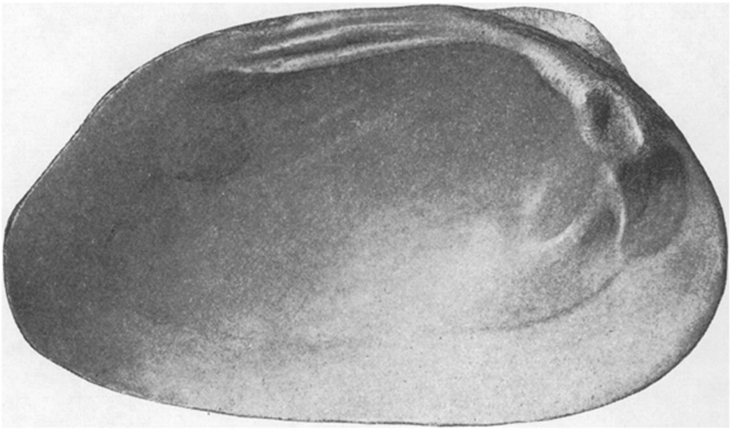


Fig. 12b.

PLATE V. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE VI.

(*Drawings by G. T. Kline.*)

Fig. 13a.—External view of left valve of a new species, *Truncilla Lefevrei* Utterback. ♂ (Nat. size.)

Fig. 13b.—Internal view of right valve of *T. Lefevrei.* ♂

Fig. 13c.—External view of left valve of *T. Lefevrei.* ♀

Fig. 13d.—Internal view of right valve of *T. Lefevrei.* ♀

Fig. 14a.—External view of left valve of a new species, *Truncilla Curtisi* Frierson and Utterback. ♂ (Nat. size).

Fig. 14b.—Internal view of right valve of *T. Curtisi.* ♂

Fig. 14c.—External view of left valve of *T. Curtisi.* ♀

Fig. 14d.—Internal view of right valve of *T. Curtisi.* ♀

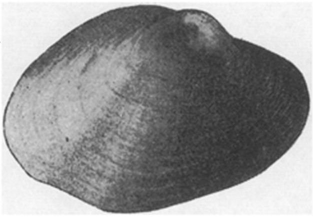


Fig. 13a.

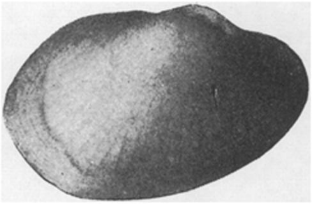


Fig. 13c.

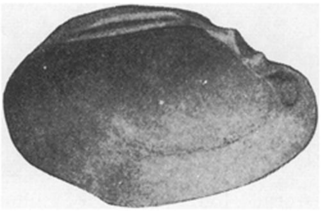


Fig. 13b.

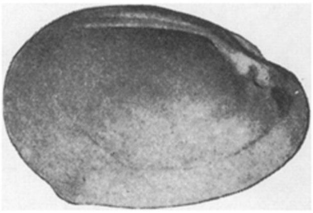


Fig. 13d.

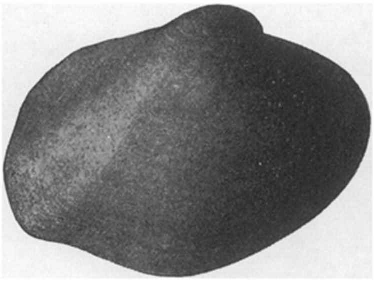


Fig. 14a.

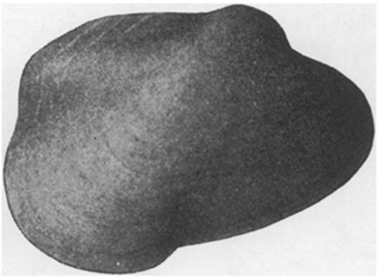


Fig. 14c.

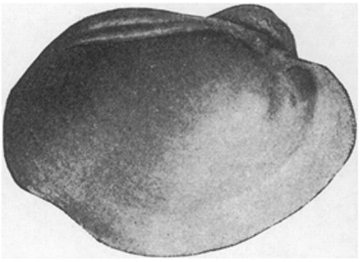


Fig. 14b.

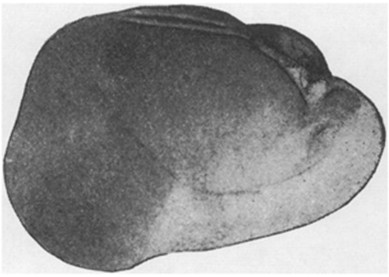


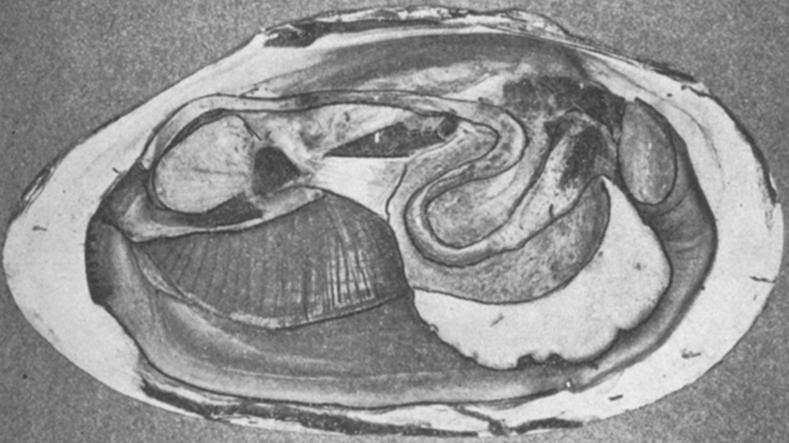
Fig. 14d.

PLATE VI. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE VII.

Fig. 15.—*Anodonta grandis* Say ♀—Actual longi-section of the visceral mass showing entire alimentary tract, protractor muscle and other animal structures in left valve. (¾ Nat. size).

Fig. 16.—*Megalonaias heros* (Say) ♀ Photograph of gravid specimen showing animal structure in left valve. (¾ Nat. size).



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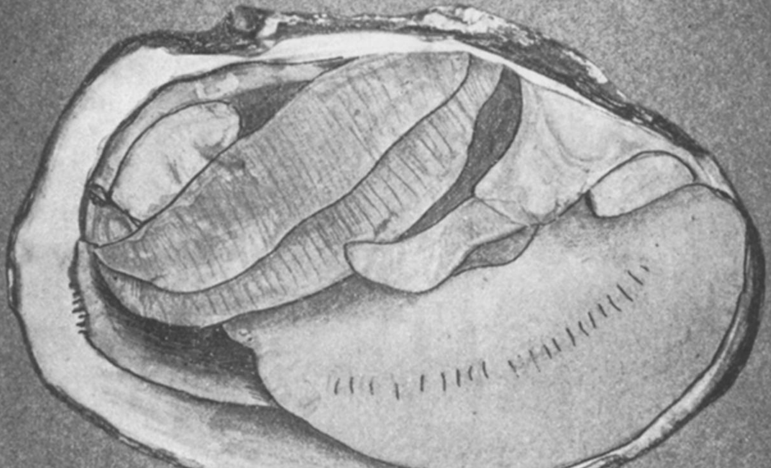

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PLATE VII.

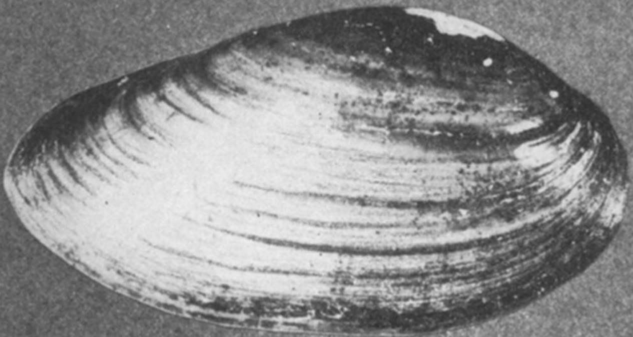
EXPLANATION OF PLATE VIII.

Fig. 17A.—*Lampsilis anodontoides* (Lea). ♂—Extenal view of right valve. (¾ Nat. size).

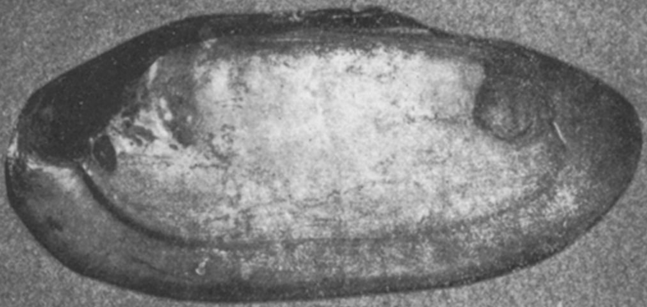
Fig. 17B.—*L. anodontoides.* ♂—Internal view of left valve.

Fig. 18A.—*Lampsilis fallaciosa* (Smith) Simpson. ♀—External view of right valve. (¾ Nat. size).

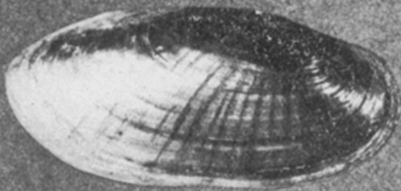
Fig. 18B.—*L. fallaciosa.* ♀—Dorsal view showing *Lampsiline* beak sculpture.



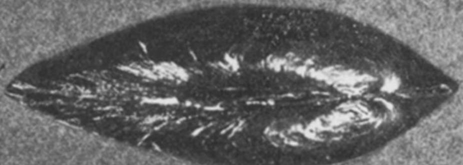
17A



17B



18A



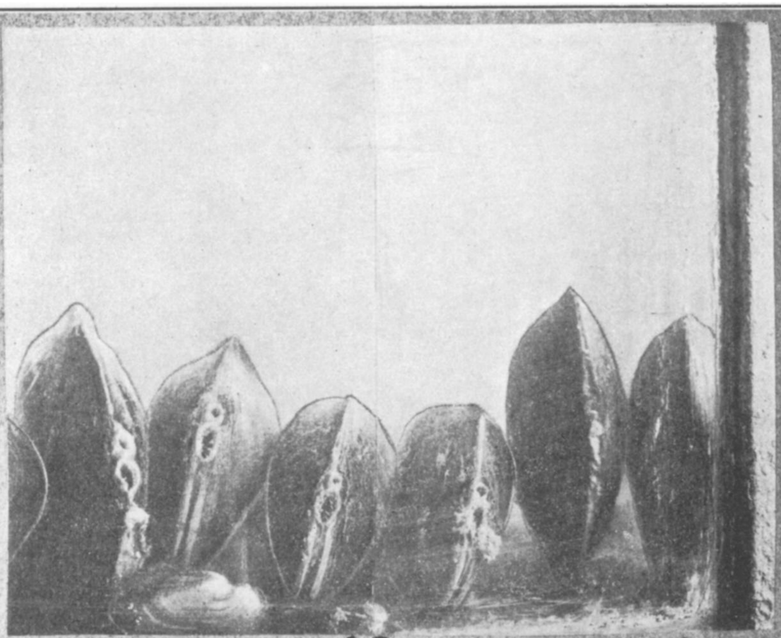
18B

PLATE VIII.

EXPLANATION OF PLATE IX.

Fig. 19.—Posterior views of live mussels in aquarium showing "siphons" open in act of feeding and discharging wastes. Reading from left to right are:—One *P. laevissima* ♂, *L. fragilis* ♀ (next three) and *L. suborbiculata* ♀ (two at extreme right). Young of *L. fragilis* (lateral view) and *Q. quadrula* (umbonal view) lie in front.

Fig. 20—Continued aquarium view showing narrowly open "siphons" of *A. rariplicata* on the left and the extremely extended "siphons" of *P. laevissima* ♂ on the right (lateral view).



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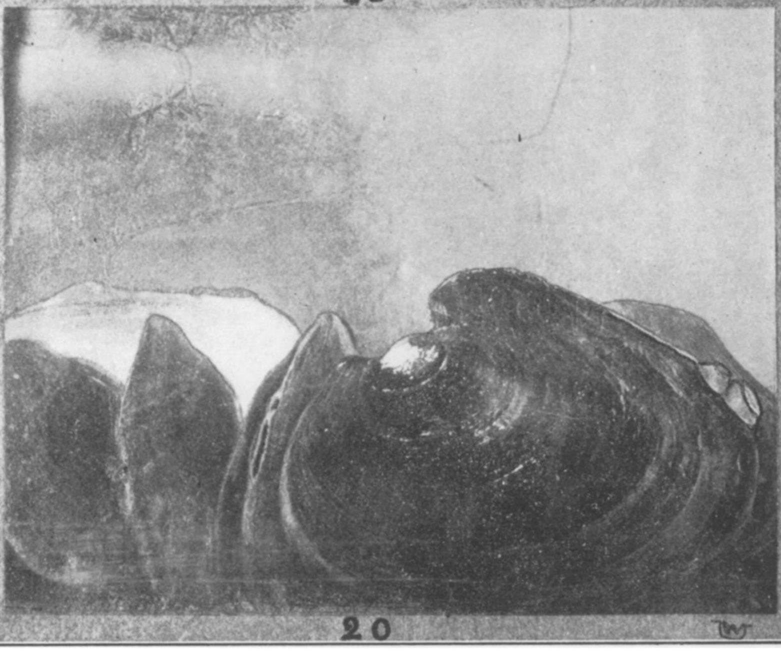

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PLATE IX.

EXPLANATION OF PLATE X.

Fig. 21.—Platte River below a small falls showing a quiet, sheltered "pocket" where juveniles and small species of mussels congregate in great numbers. Note dead shells on the rocky bar.

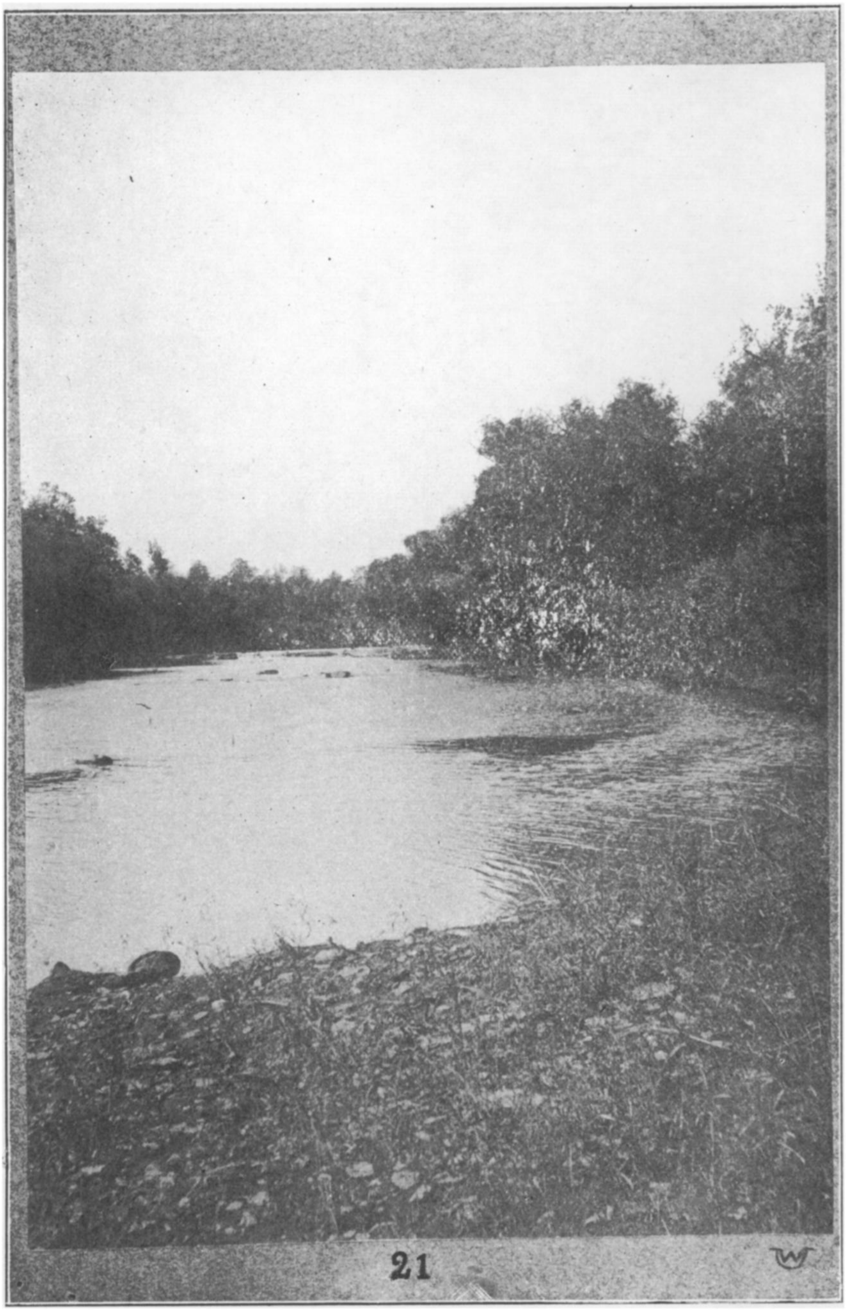

PLATE X. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XI.

Fig. 22.—Limestone cliffs and mussel bed at the foot above Dixon Falls, Platte River. Abundance of lime in the water here contributes to the unusual growth of shell.

Fig. 23.—"Fishing" for mussels in the West Bayou of Lake Contrary St. Joseph. A garden rake is used in deep water, but hand, picking, where-ever possible, is the most successful.

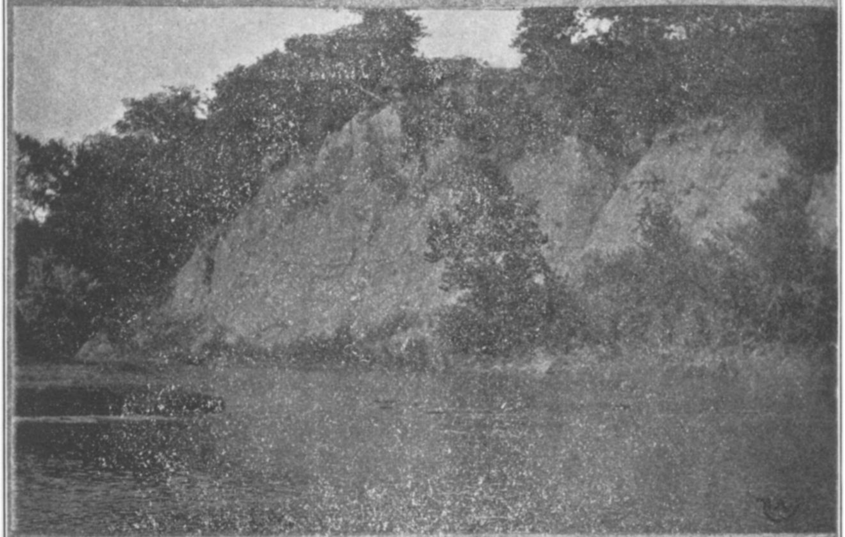

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PLATE XI. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XII.

Fig. 24.—Beach of a North-West Missouri Lake showing the common sight of a pile of cleaned mussel shells made by a musk-rat after feeding on the soft parts. These ravages, as well as the receding of the water, tend greatly to deplete the mussel beds.

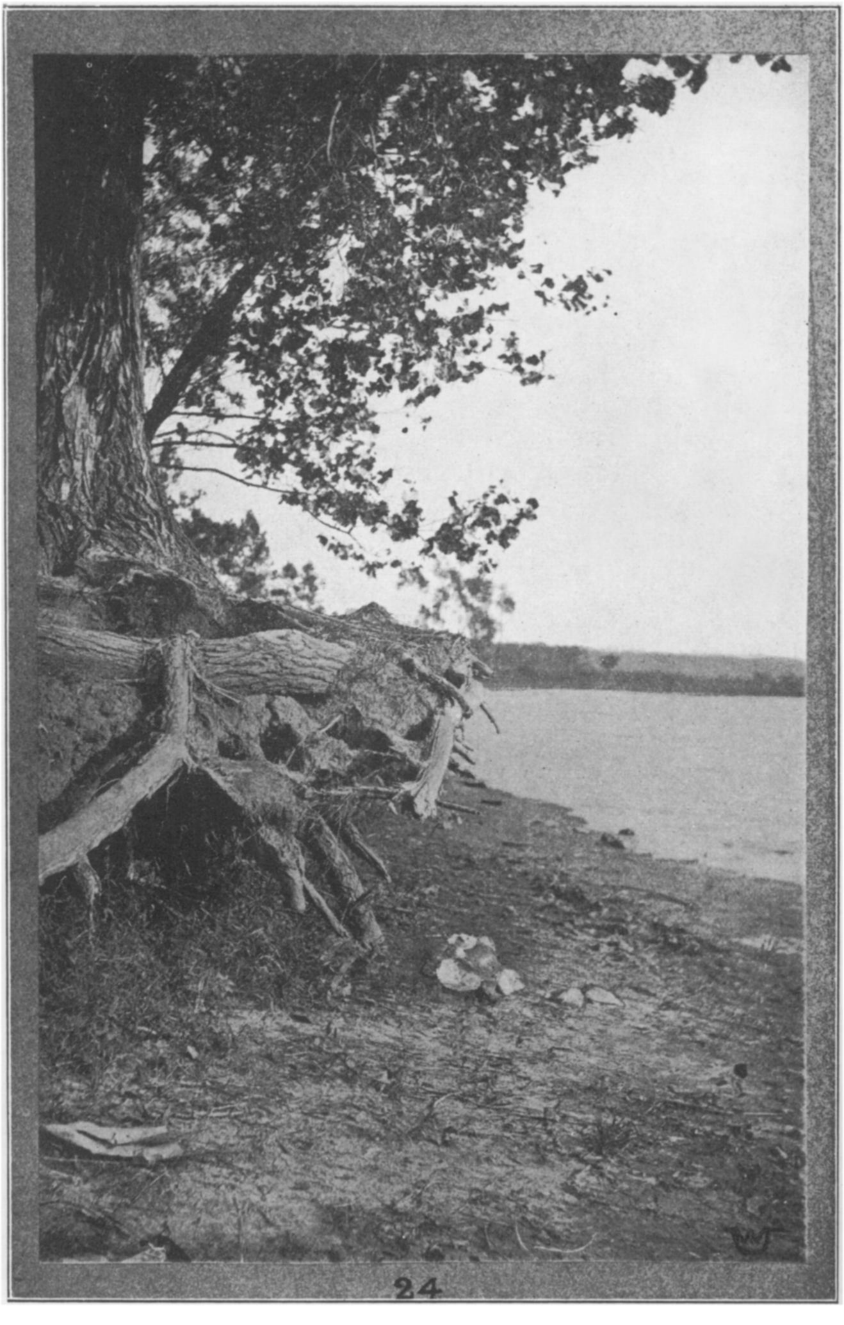

PLATE XII. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XIII.

Fig. 25.—Lake Contrary, (St. Joseph),—the home of the *Anodontinae,* especially *Lastena suborbiculata.* Although originally the bed of the Missouri River, yet the only river species found here are:—*Q. quadrula* and *P. laevissima.*

Fig. 26.—One-and-Two River, Corby Mill.—Above the dam the mussel fauna is different, due to the limitation of the range of certain fish as distributors of mussel life in the parasitic stage.

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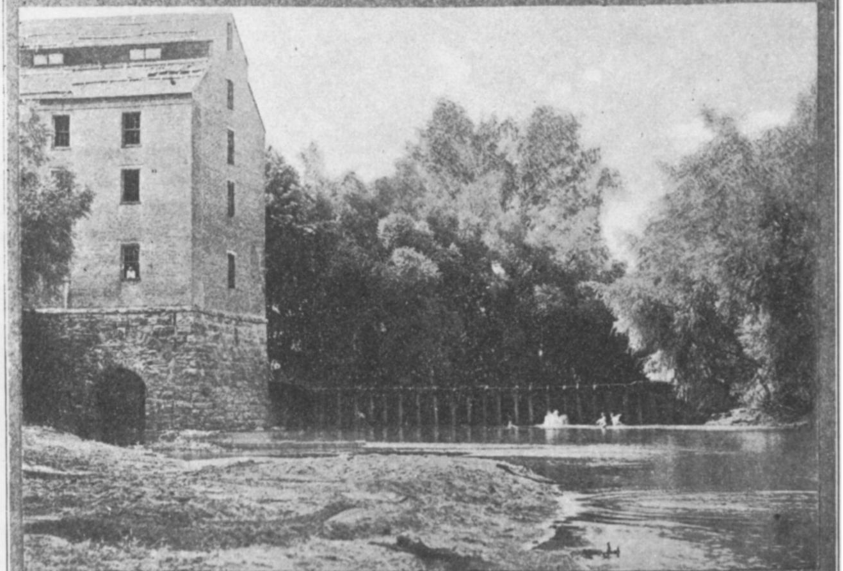

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PLATE XIII. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XIV.

Fig. 27.—Shells *in situ* (above and to right of hat) embedded in a bank along Beck's Slough, St. Joseph. This shows a former mussel life now extinct there.

PLATE XIV.

EXPLANATION OF PLATE XV.

Fig's. 28.—A and B *Cumberlandia monodonta* (Say) ♀, Miss. R., LaGrange.

Fig's. 29 A and B.—*Fusconaia undata* (Barnes) ♀, Miss. R., Hannibal

Fig's. 30 A and B.—Adult *F. undata trigonoides* Frierson MS. ♀ Platte R., Agency Ford.

Fig's. 30 C and D.—Juvenile of *trigonoides*.

Fig's 31 A and B.—*F. undata trigona* (Lea) ♀, Osage R., Warsaw.

Fig's. 32 A and B.—Adult *F. flava* (Raf.) ♂, White R., Hollister

Fig's 32 C and D.—Young of *flava*.

Fig's 33 A. and B.—*F. hebetata* (Conrad) ♀, Osage R., Warsaw

Fig's 34 A and B.—*F. ebena* (Lea) ♀, Miss. R., LaGrange.

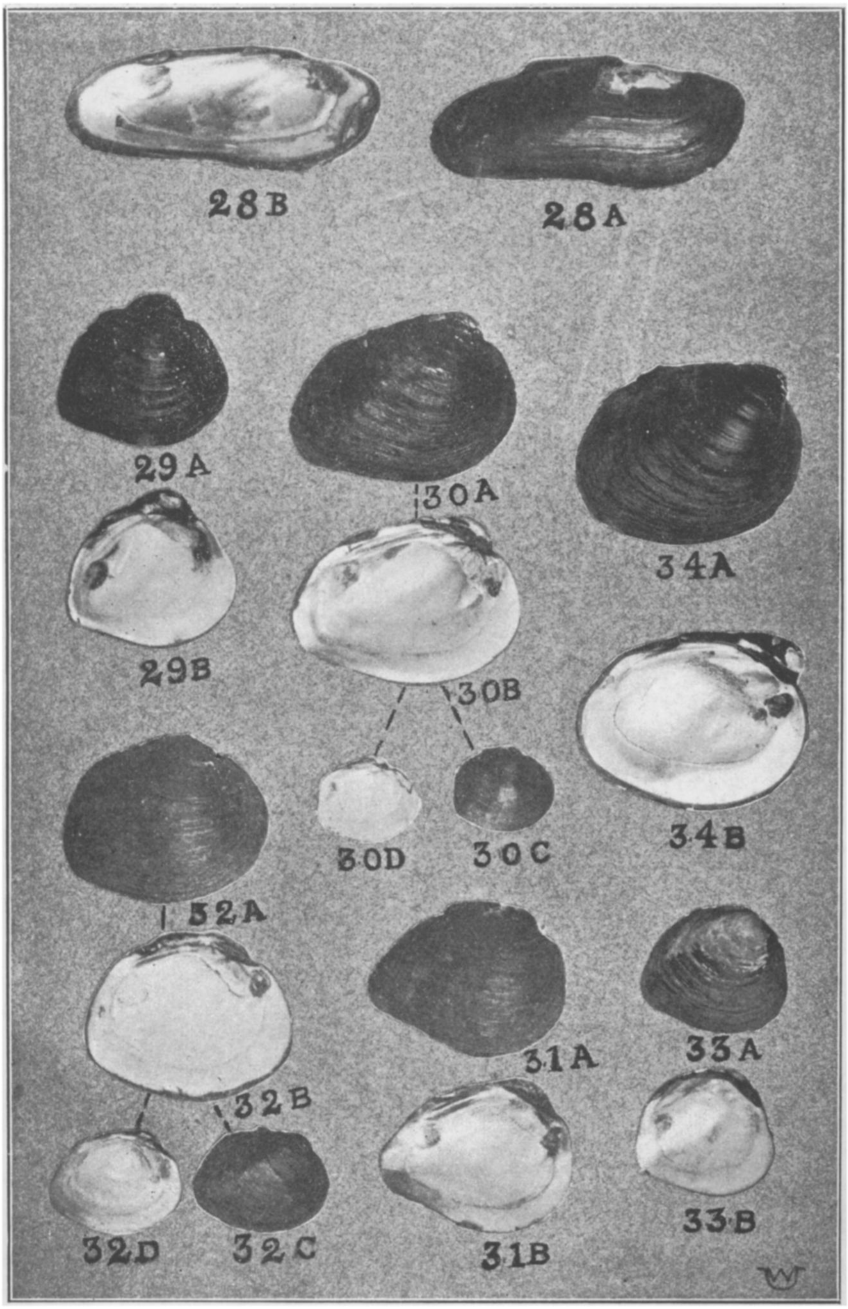

PLATE XV. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XVI.

Fig's 35 A and B.—*Amblema peruviana* (Lamarck) ♀, Osage R., Osceola.

Fig's 36 A and B.—*A. rariplicata* (Deshayes) ♀, Platte R., Dixon Falls.

Fig's 36 C and D.—*A. rariplicata* (Des) ♂, Tarkio R., Craig.

Fig's 37 A and B.—*A. perplicata* (Conrad) ♀, St. Francis R., Greenville.

Fig's 38 A and B.—*A. perplicata Quintardi* (Cragin) ♀, White R., Hollister.

Fig's 38 C and D.—*A. perplicata Quintardi* (Cragin) ♀, Osage, R. Proctor.

Fig's 39 A and B.—*A. plicata costata* (Raf.) ♂, Chariton R., Kern

Fig's 39 C and D.—Juvenile of *costata.*—Same locality as adult.

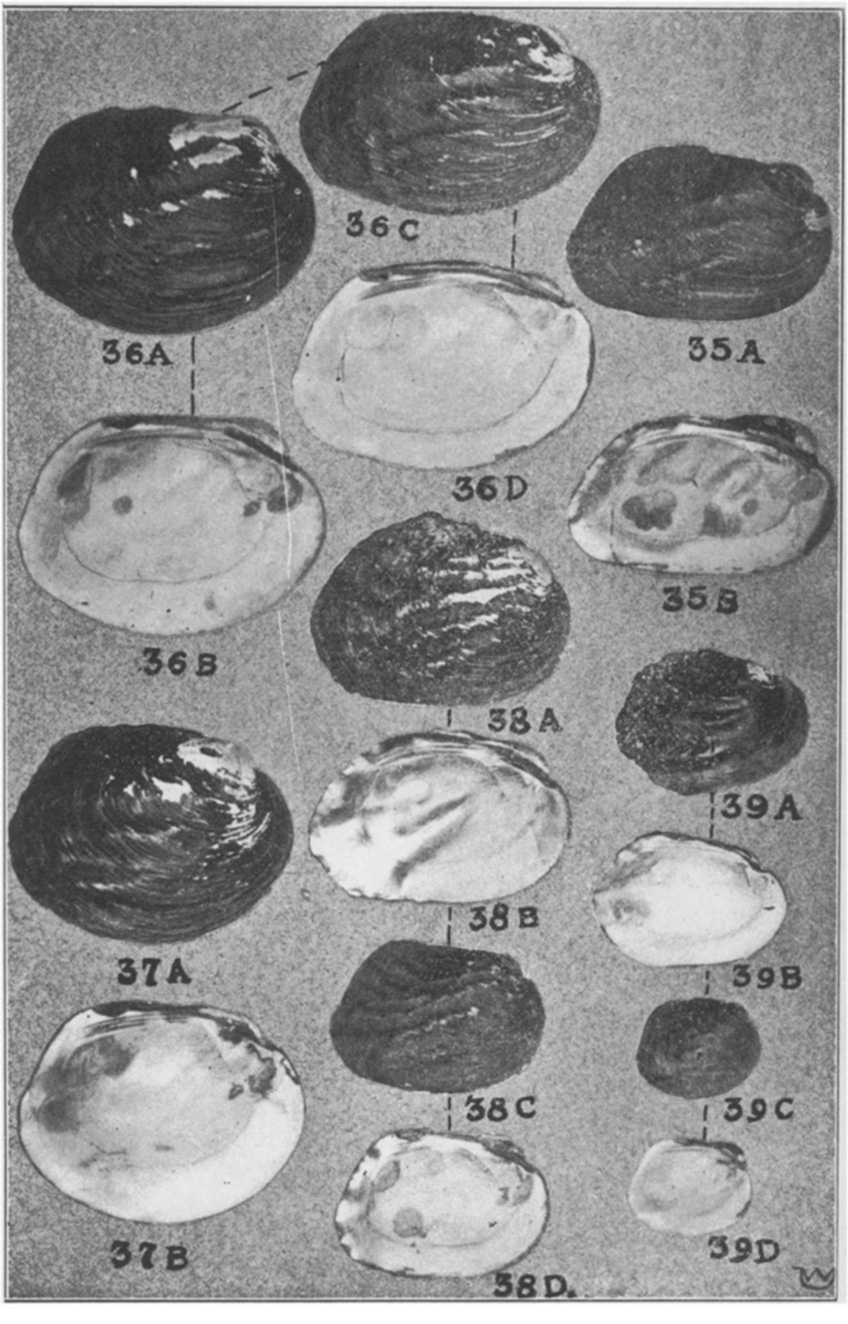

PLATE XVI.

EXPLANATION OF PLATE XVII.

Fig's 40 A and B.—Adult *Megalonaias heros* (Say) ♀, Platte R. Garretsburg.

Fig's 40 C and D.—Juvenile *heros*, Osage R., Monegaw Springs.

Fig's 40 E and F.—Young *heros*, Osage R., Warsaw.

Fig's 41 A and B.—*Quadrula pustulosa* (Lea) ♀, Miss. R., Hannibal.

Fig's 42 A and B.—Adult *Q. pustulosa schoolcraftensis* (Lea) ♀, Platte R., Claire.

Fig's 42 C and D.—Young *schoolcraftensis*.—Same locality as adult.

Fig's 43 A and B.—*Q. pustulosa asperata* (Lea) ♂, Osage R., Bagnell.

Fig's 44 A and B.—*Q. nodulata* (Raf.) ♂, Miss. R., Hannibal.

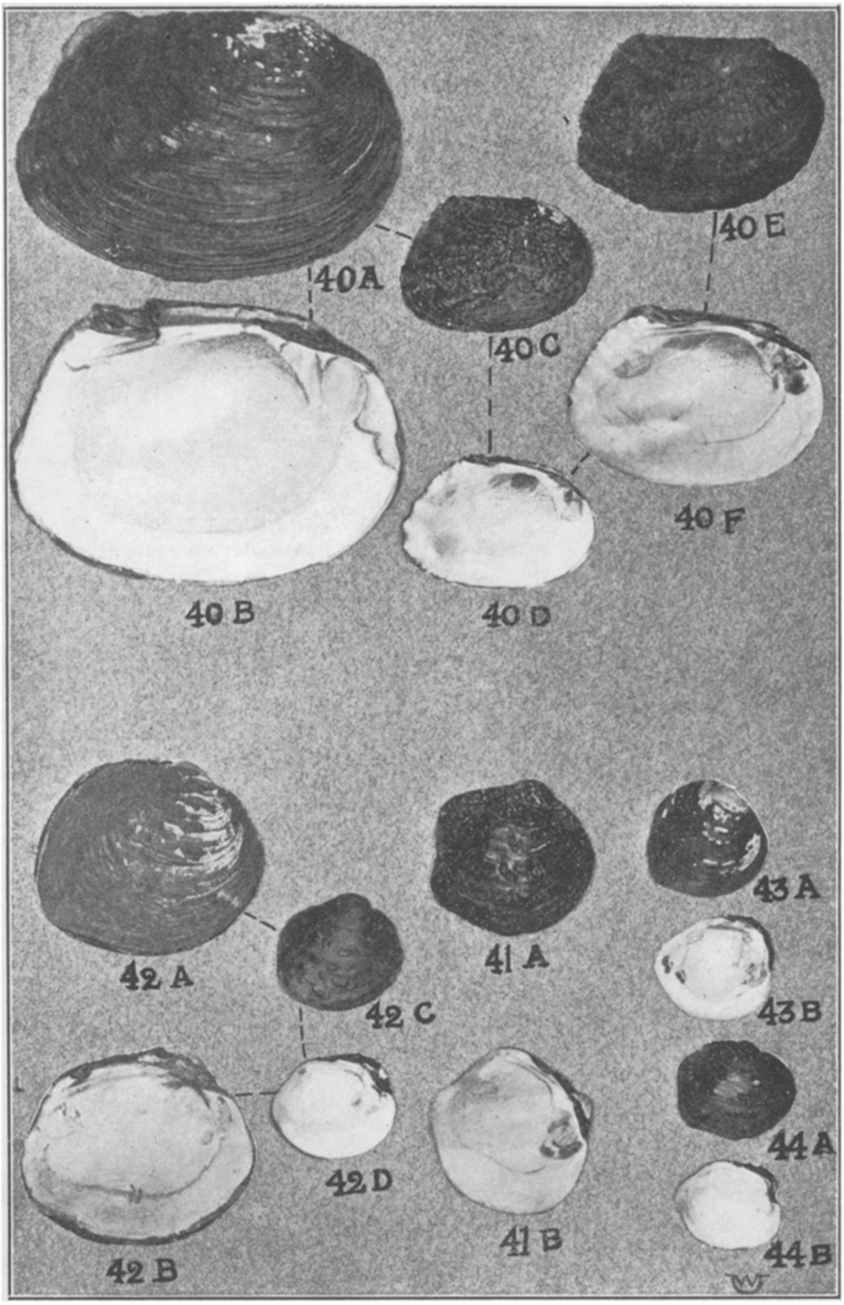

PLATE XVII.

EXPLANATION OF PLATE XVIII.

Fig's 45 A and B.—*Q. quadrula* (Raf.) ♀, Lake Contrary, St. Joseph.

Fig's 45 C and D.—*Q. quadrula* ♂. Same locality as female.

Fig's 45 E and F.—*Q. quadrula* ♂, Flat Cr., Sedalia.

Fig's 46 A and B.–*Q. quadrula* ♀, L. Contrary.—A common pathologic shell found in the N. W. Mo. Lakes.

Fig's 47 A and B.—*Q. quadrula contraryensis* Utterback ♀, L. Contrary.—*A new variety.*

Fig's 48 A and B.—*Q. fragosa* (Conrad) ♀, Miss. R., Hannibal.

Fig's 49 A and B.—*Q. aspera* (Lea) ♀, Osage R., Warsaw.

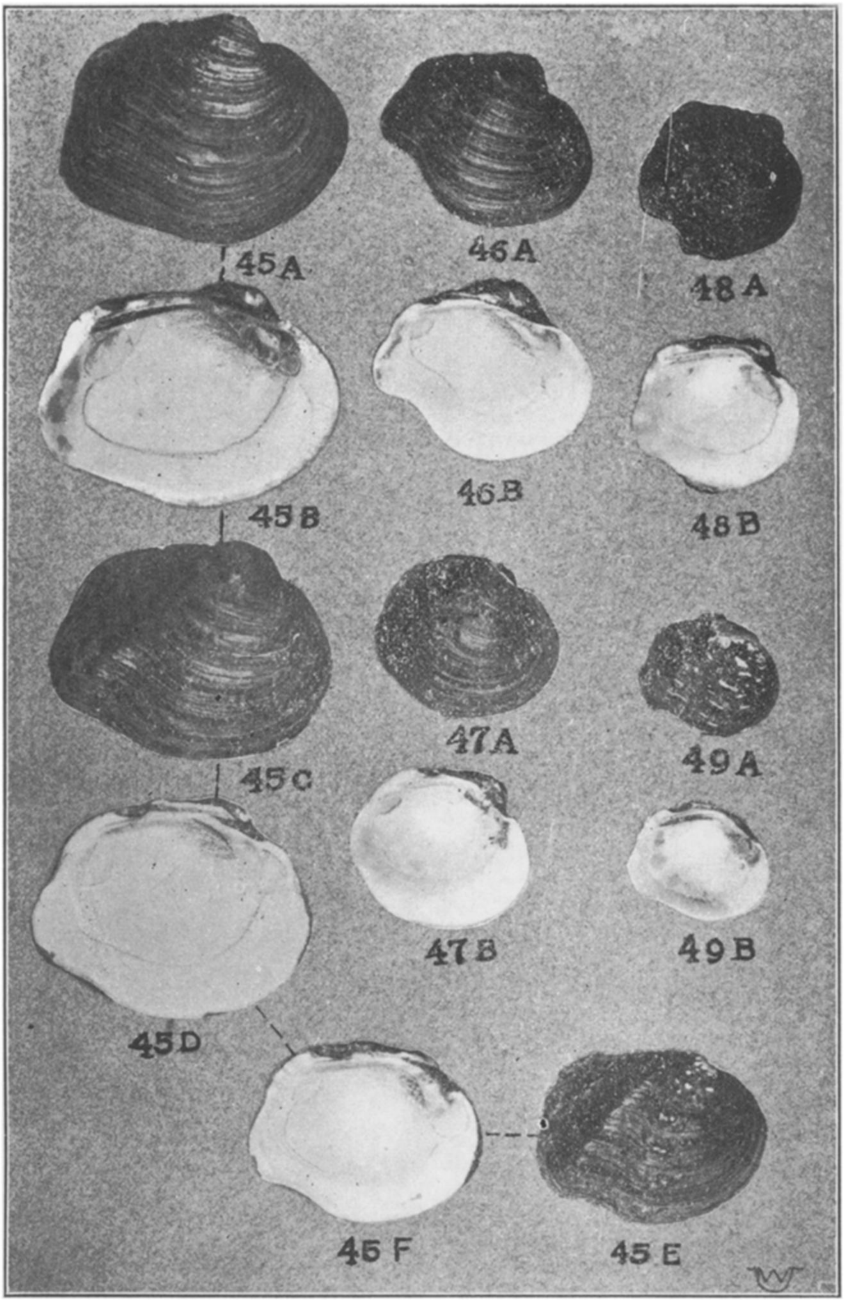

PLATE XVIII. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XIX.

Fig's. 50 A and B.—*Q. verrucosa* (Raf.) ♂, Grand R., Darlington.

Fig's 50 C and D.—Young *Q. verrucosa* (Raf.) ♀, White R., Hollister.

Fig's 51 A and B.—*Q. nobilis* (Conrad) ♀, Marais des Cygnes R., Rich Hill.

Fig's 52 A and B.—*Q. cylindirca* (Say) ♀, Black R., Williamsville.

Fig's 53 A and B.—*Q. metanevra* (Raf.) ♂, Meramec R., Meramec Highlands.

Fig's 54 A and B.—*Rotundaria tuberculata* (Raf.) ♀, Osage R., Schell City.

Fig's 55 A and B.—*R. granifera* (Lea) ♀, Miss. R., LaGrange.

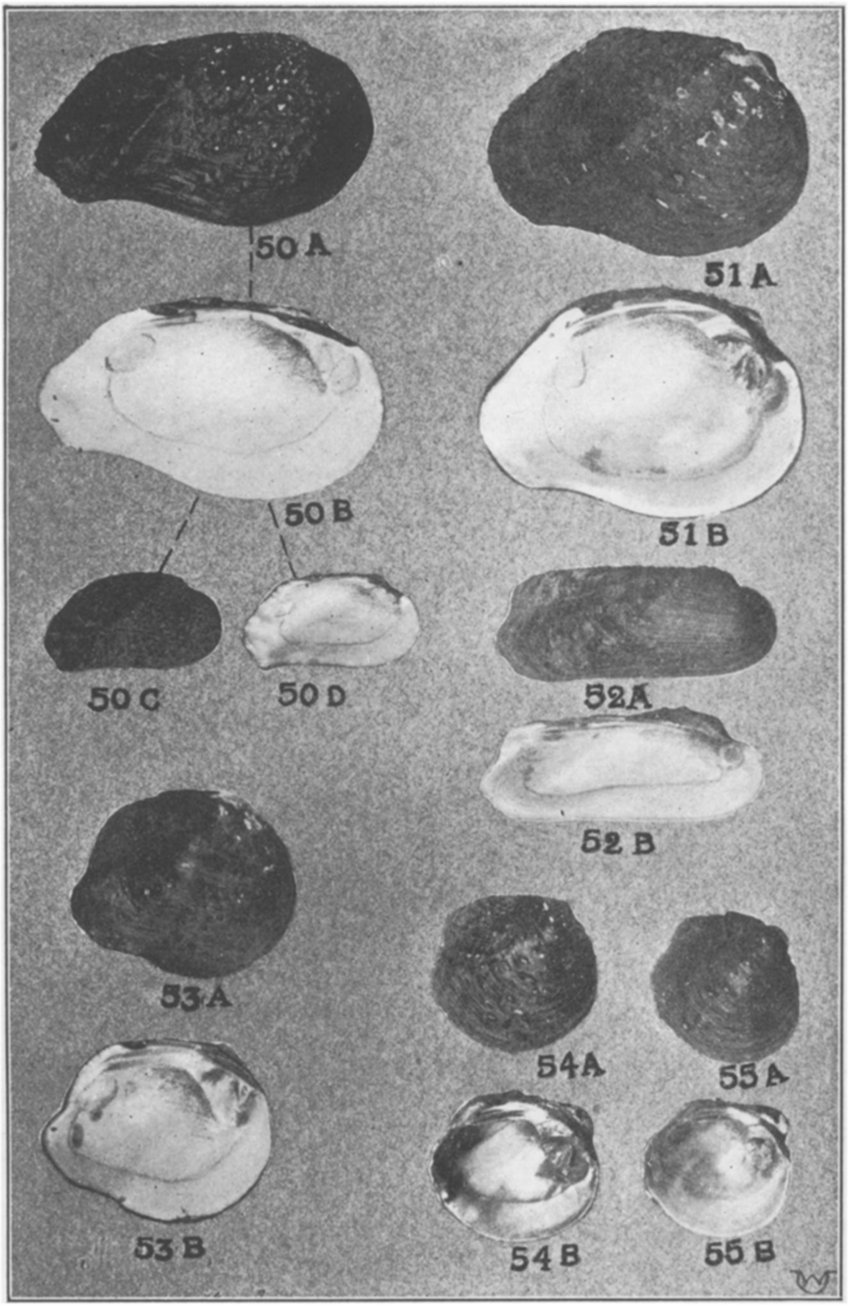

PLATE XIX. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XX.

Fig's 56 A and B.—*Plethobasus aesopus* (Green) ♀, Des Moines R., Dumas.

Fig's 56 C and D.—Juvenile of *P. aesopus.*—Same locality as adult.

Fig's 57 A and B.—*P. cooperianus* (Lea) ♀, Gascondy.

Fig's 58 A and B.—*Pleurobema obliquum pyramidatum* (Lea) ♀, Osage R., Baker, Mo.

Fig's 59 A and B.—*P. catillus* (Conrad) ♀, Black R., Williamsville.

Fig's 60 A and B.—*P. coccineum* (Conr.) ♀, White R., Hollister.

Fig's 61 A and B.—*P. obliquum coccineum* (Conr.) ♀, Osage R., Warsaw.

Fig's 61 C and D.—*Young P. obliquum coccineum* (Conr.).—Same locality as adult.

Fig's 62 A and B.—*P. obliquum catillus* (Conr.) ♀, Osage R., Colley's Ford.

Fig's 63 A and B.—*P. Utterbacki* Frierson (n. sp.) ♀, White R., Hollister.

Fig's 63 C and D.—*P. Utterbacki* F. ♂, Jack's Fork of the Current R.

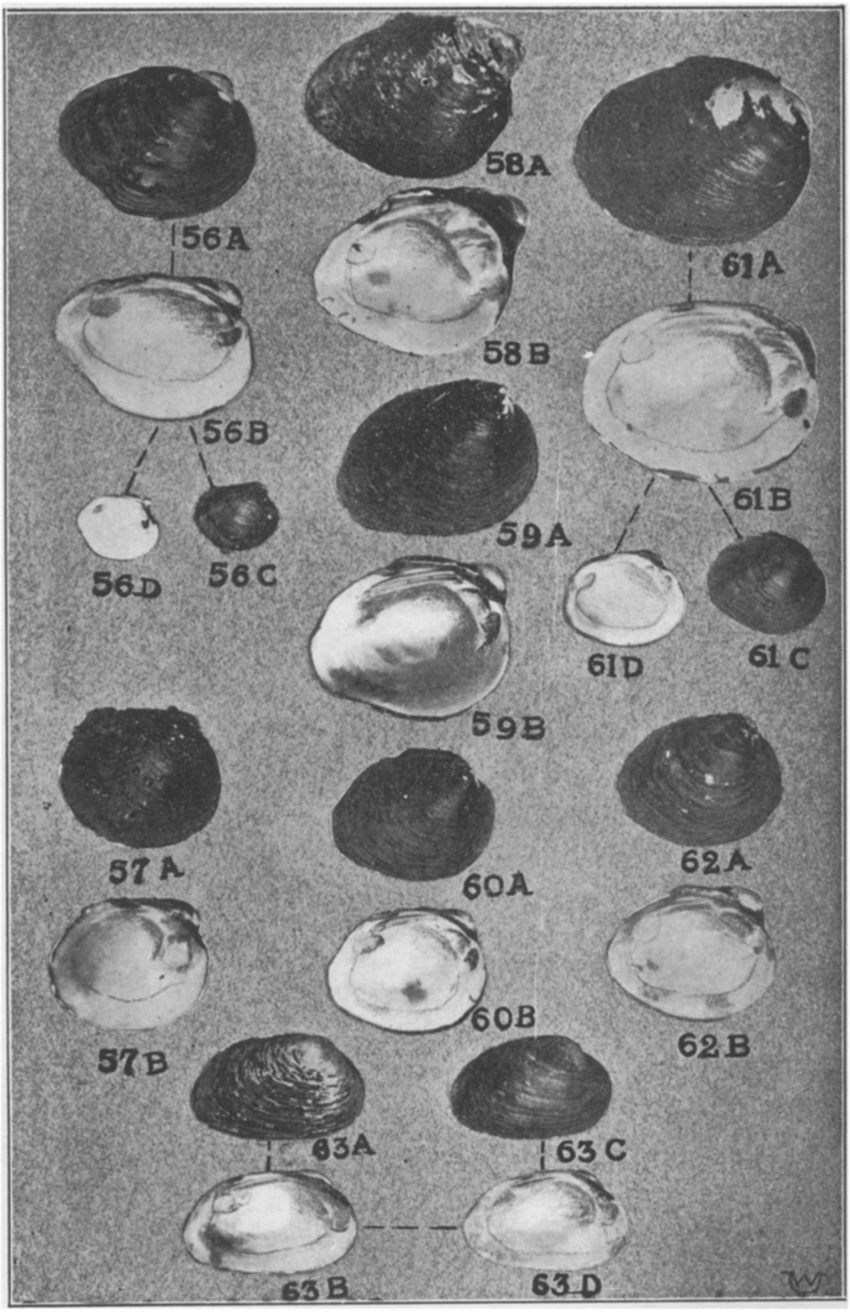

PLATE XX. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XXI.

Fig's 64 A and B.—*Elliptio nigra* (Raf.) ♂, Meramec R., Meramec Highlands.

Fig's 65 A and B.—*E. nigra* (Raf.) ♀, Miss., Hannibal.

Fig's 66 A and B.—*E. dilatata* (Raf.) ♀, Osage R., Osceola.

Fig's 67 A and B.—*E. dilatata delicata* (Simpson) ♀, White R., Hollister.

Fig's 67 C and D.—*E. dilatata delicata* (Simp.) ♂, Black R., Williamsville.

Fig's 68 A and B.—*E. dilatata subgibbosa* (Lea) ♀, Black R., Williamsville.

Fig's 68 C and D.—*E. dilatata subgibbosa* (Lea) ♂, Black R., Williamsville.

Fig's 69 A and B.—*Uniomerus tetralasma* (Say) ♀, Batterton Pond, Columbia.

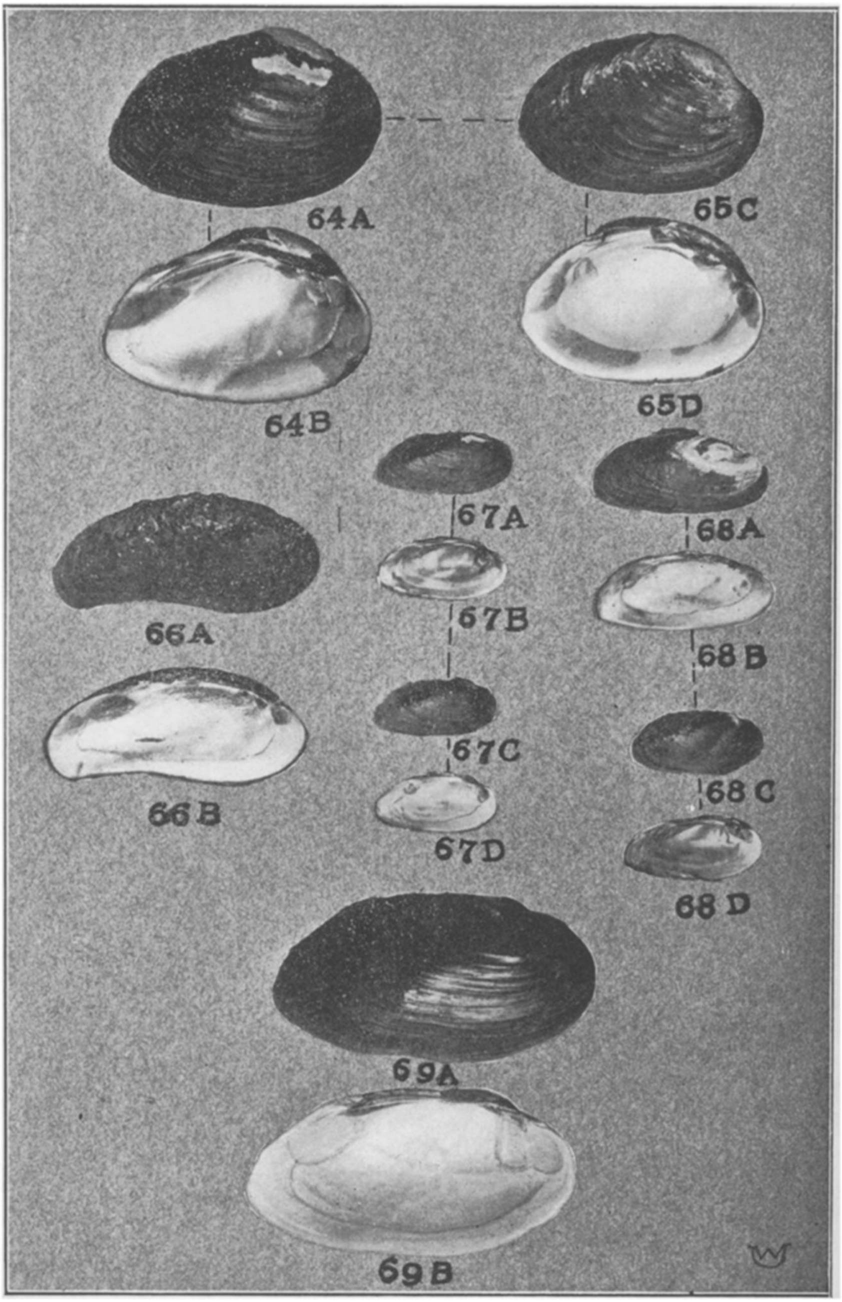

PLATE XXI. UTTERBACK ON NAIADES OF MISSOURI.

EXPLANATION OF PLATE XXII.

Fig's 70 A and B.—*Symphynota complanata* (Barnes) ♀, Big Mud Lake, Kenmoor.

Fig's 71 A and B.—*Symphynota costata* (Raf.) ♀, Black R., Williamsville.

Fig's 71 C and D.—*S. costata* (Raf.) ♂, Gasconade R., Gascondy.

Fig's 71 E and F.—*S. costata* (Raf.) ♀, Miss. R., Hannibal.

Fig's 72 A and B.—*Arcidens confragosa* (Say) ♀, Marais des Cygnes R., Papinsville.

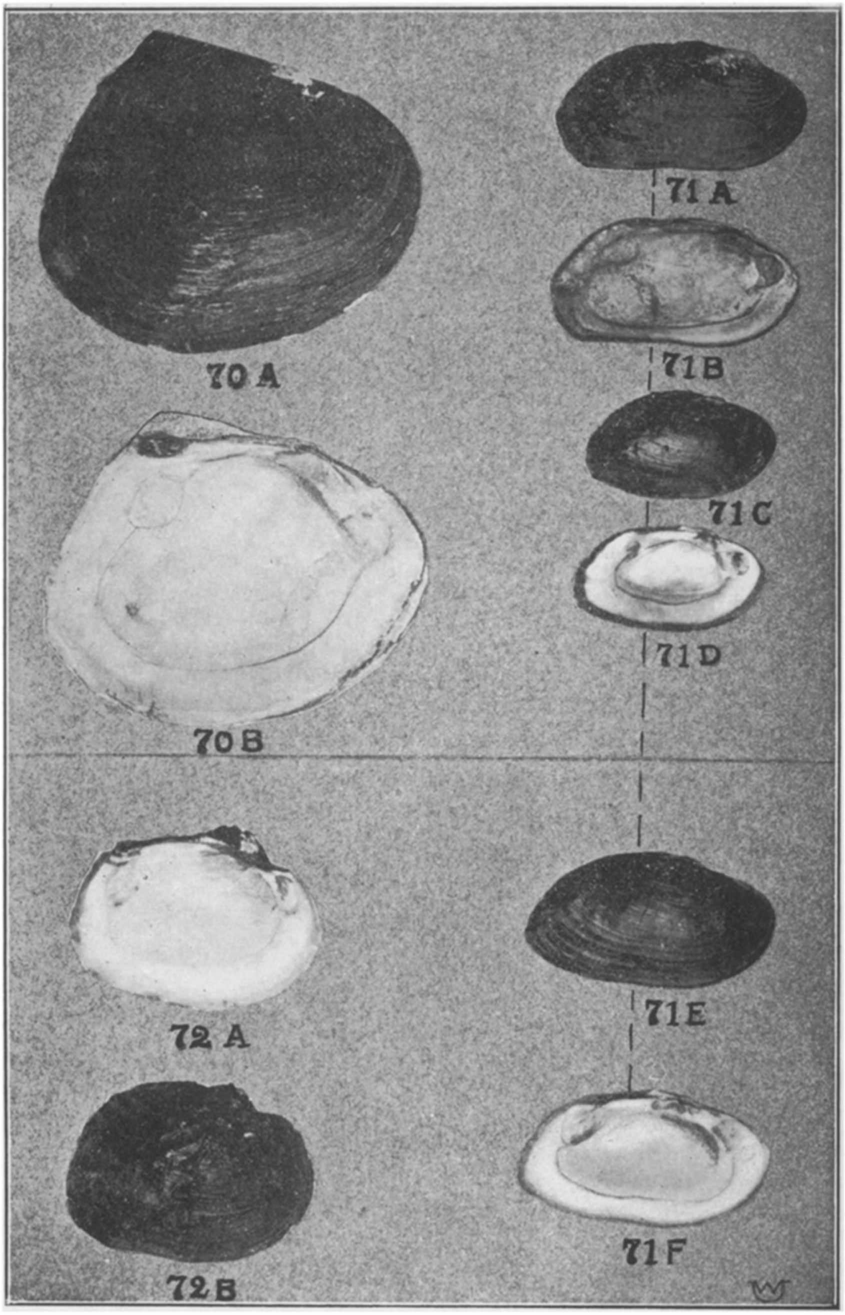

PLATE XXII. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XXIII.

Fig's 73 A and B.—*Lastena suborbiculata* (Say) ♀, Lower Lake Contrary, St. Joseph.

Fig's 73 C—F.—Juveniles of *L. suborbiculata*.—Upper L. Contrary—Note the coarse *Anodontine* beak sculpture which reaches well down on the disk.

Fig's 74 A and B.—*Lastena ohiensis* Raf.O, Singleton Lake, Halls.

Fig's 75 A and B.—*Anodonta grandis* (Say) ♀, Mud Lake, Kenmoor.

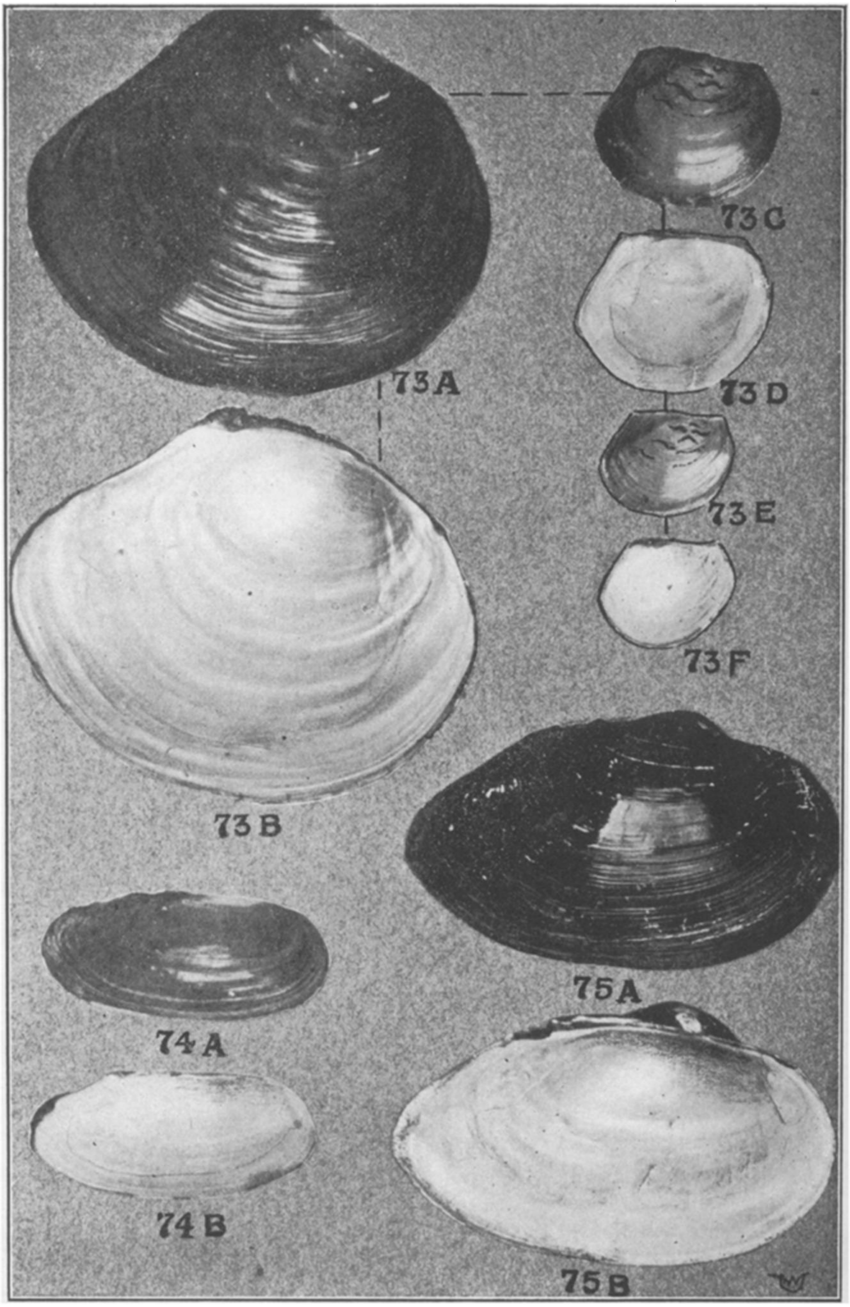

PLATE XXIII.

EXPLANATION OF PLATE XXIV.

Fig's 76 A and B.—*Anodonta Danielsii* Lea ♀, Lost Cr., Amity.

Fig's 77 A and B.—*A. dakotana* Frierson ♀, L. Contrary, St. Joseph.

Fig's 78 A and B.—*Alasmidonta marginata* Say ♀, Gasconade R. Gascondy.

Fig's 79 A and B.—*A. calceolus* (Lea) ♀, Jack's Fork, Current R.

Fig's 79 C and D.—*A. calceolus*, ♂, White R., Branson.

Fig's 80 A and B.—*Strophitus edentulus* (Say) ♀, Osage R., Linn Cr

Fig's 80 C and D.—*S. edentulus* ♂, White R., Branson.

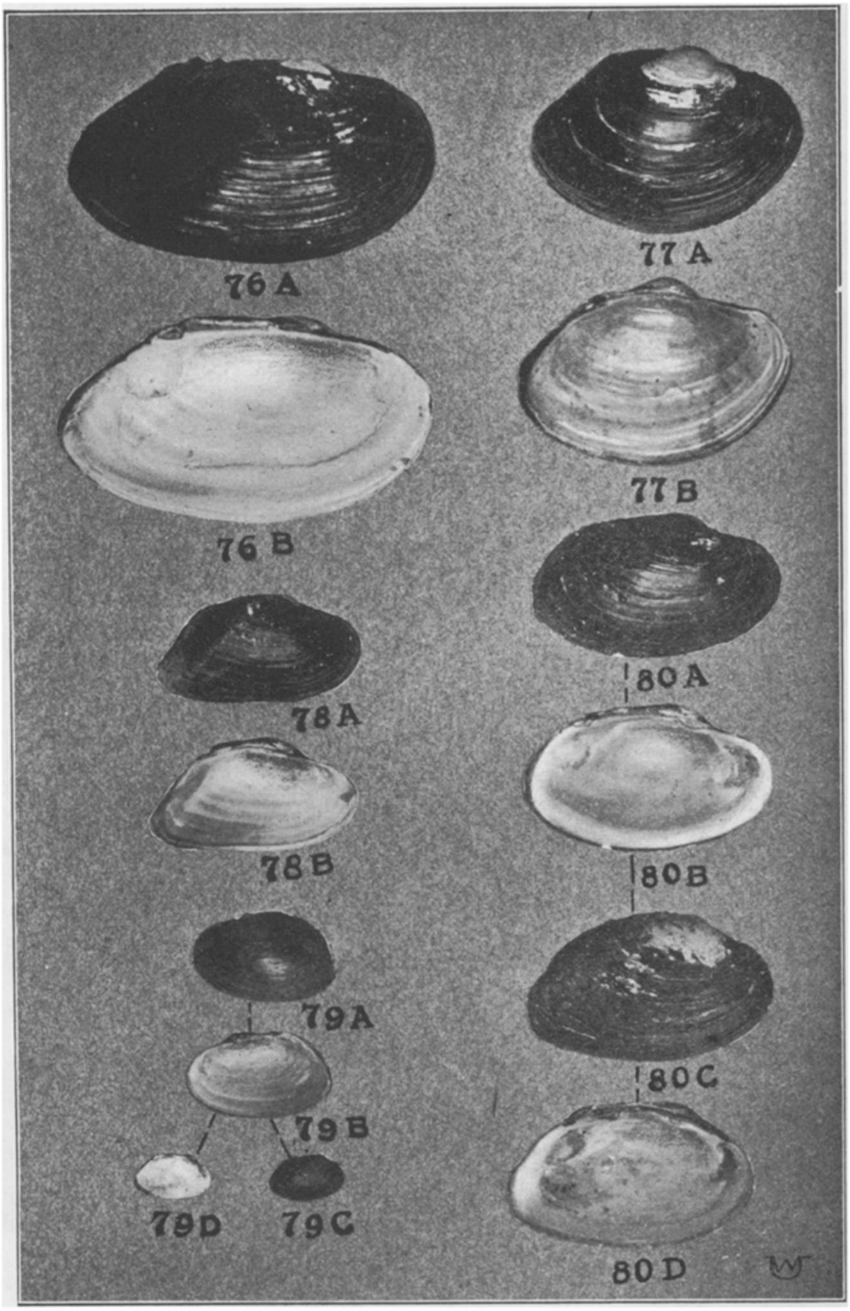

PLATE XXIV. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XXV.

Fig's 81 A and B.—*Ellipsaria clintonesnsis* (Simpson) ♀, White R., Hollister.

Fig's 82 A and B.—*Obliquaria reflexa* Raf. ♂, Platte R., Platte R. Sta.

Fig's 82 C and D.,—*O. reflexa* Raf. ♀, Osage R., Monegaw Springs.

Fig's 82 E and F.—*Juvenile reflexa.*—Crow's Fork, Fulton.

Fig's 83 A and B.—*Cyprogenia Aberti* (Conrad) ♀, St. Francis R., Greenville.

Fig's 84 A and B.—*Obovaria* (*Pseudoon*) *ellipsis* (Lea) ♀, Grand R., Sumner.

Fig's 85 A and B.—*Nephronaias ligamentina* (Lamarck) ♀, Meramec R., Fern Glen.

Fig's 86 A and B.—*N. ellisiformis* (Conrad) ♂, Osage R., Warsaw.

Fig's 86 C and D.—*N. ellipsiformis* (Con.) ♀, Niangua R., Hahatonka.

Fig's 87 A and B.—*N. Pleasii* (Marsh) ♀, White R., Branson.

Fig's 87 C and D.—N. *Pleasii* (Marsh) ♂, White R., Branson.

Fig's 88 A and B.—*Amygdalonaias truncata* (Raf.) ♂, Osage R., Schell City, Mo.

Fig's 89 A and B.—*A. donaciformis* (Lea) ♂, Grand R., Gallatin.

Fig's 89 C and D.—*A. donaciformis* (Lea) ♀, One-and-Two R., St. Joseph.

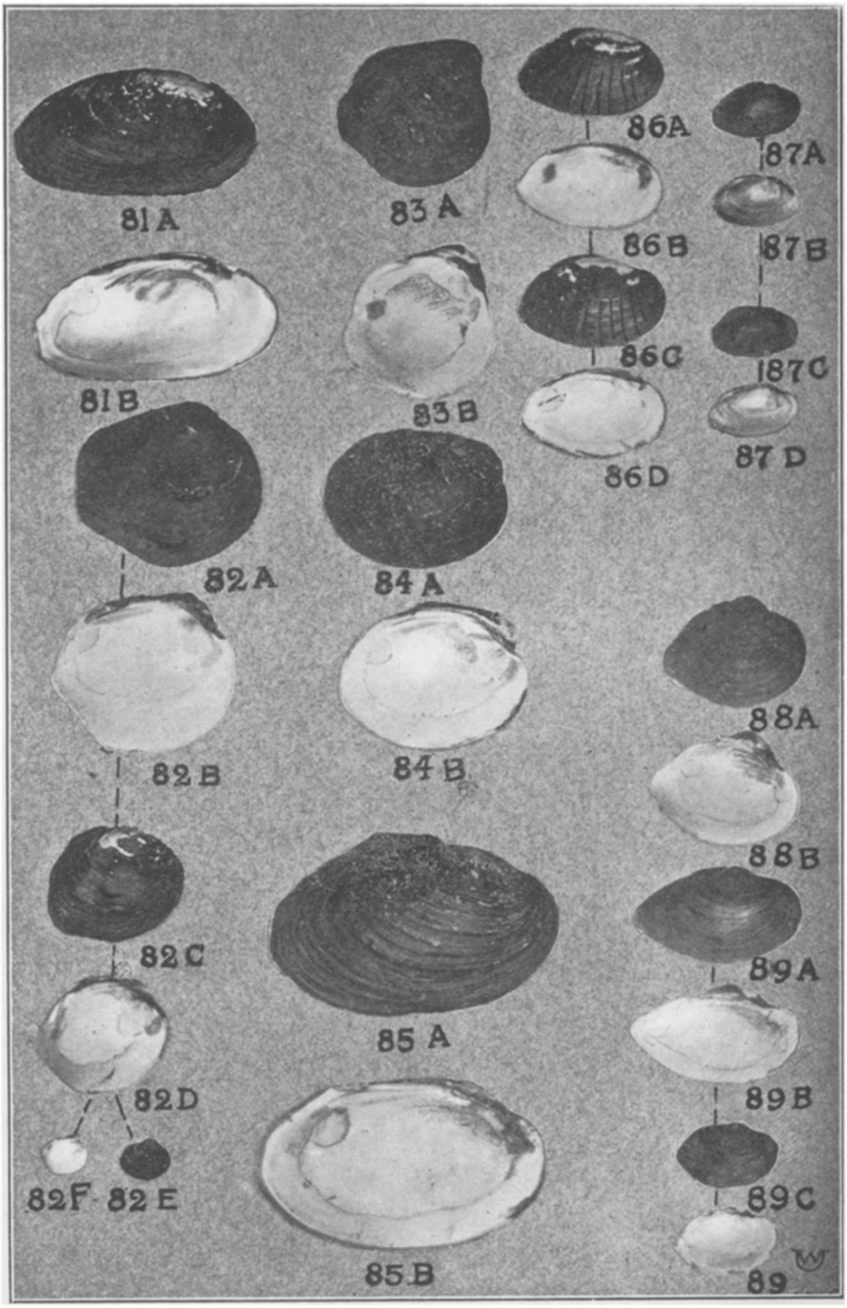

PLATE XXV. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XXVI.

Fig's 90 A and B.—*Lasmonos fragilis* (Raf.) ♀, One–and–Two River, St. Joseph. Fig. 90 B is the photograph of the animal in the left valve showing the gravid marsupium.

Fig's 90 C and D.—*L. fragilis* (Raf.) ♂, Platte R., Agency Ford.

Fig. 90 D.—A photograph of soft parts in left valve.

Fig's. 91 A and B.—*Lasmonos Simpsoni* (Ferriss) ♀, White R., Branson.

Fig's 92.—A and B.—*Proptera purpurata* (Lamarck) ♂, White R., Forsyth.

Fig's 92 C and D.—*Proptera purpurata* (Lamarck) ♀, White R., Forsyth.

Fig's 93 A and B.—*Prop. capax* (Green) ♀, Miss. R., Hannibal. Fig. 93b shows photograph of animal with gravid marsupium. Note non-specialized post-ventral mantle margin.

Fig's 94 A and B.—*Prop. laevissima* (Lea) ♀, Mud Lake, Kenmoor.

Fig's 94 C and D.—Juveniles of *laevissima*, L. Contrary, St. Joseph.

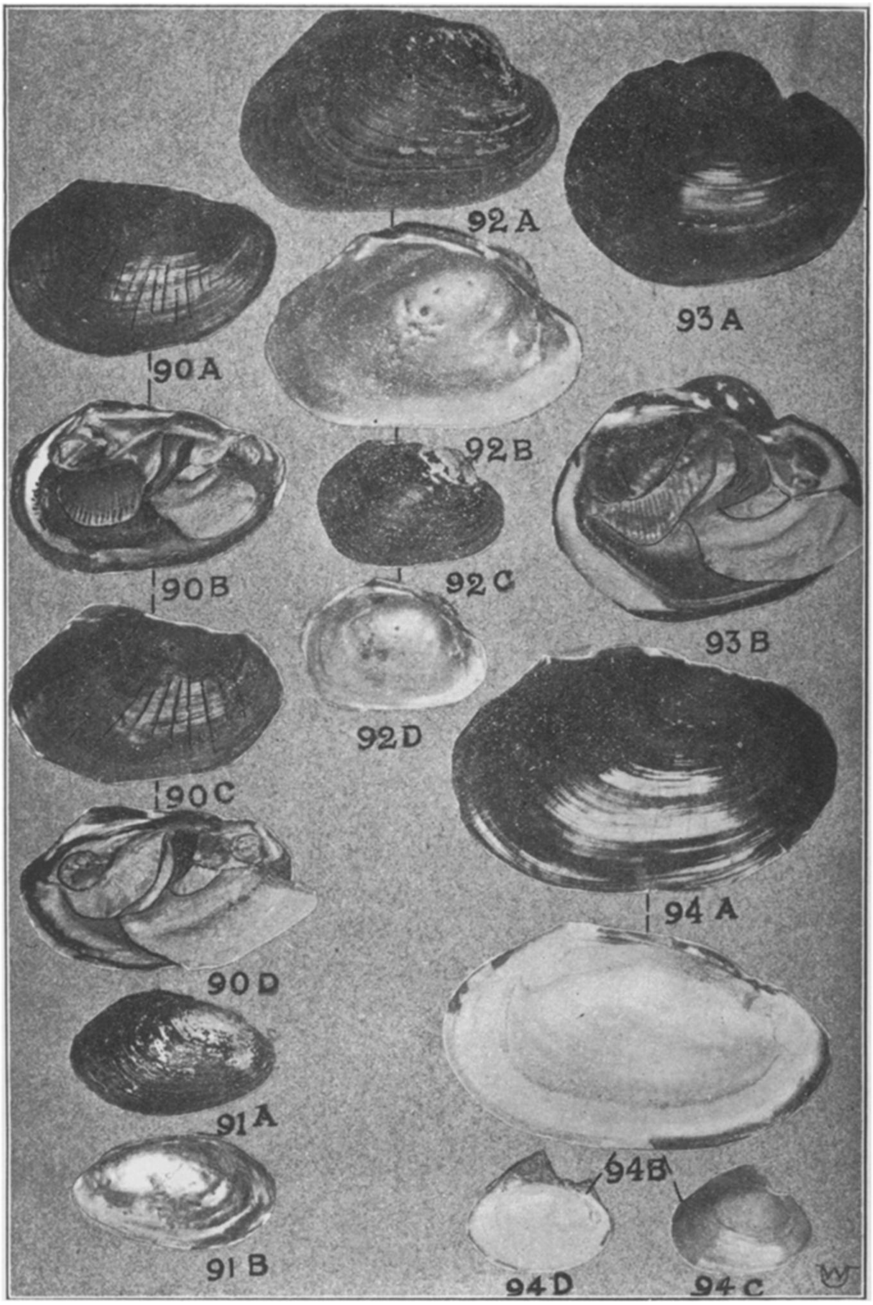

PLATE XXVI. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XXVII.

Fig's 95 A and B.—*Carunculina parva* (Barnes) Singleton Lake, Halls.

Fig's 95 C and D.—*C. parva* (Barnes) ♂, Artificial Pond, Columbia.

Fig's 96 A and B.—*Eurynia (Micromya) lienosa* (Conrad) ♂, Black R., Williamsville.

Fig's 96 C and D.—*E (M) lienosa* (Con) ♀, Black R., Williamsville.

Fig's 97 A and B.—*E. (M) iris* (Lea) ♀, White R., Hollister.

Fig's 98 A and B.—*E (M.) brevicula* (Call) ♂, White R., Branson.

Fig's 98 C and D.—*E (M.) brevicula* (Call) ♀, Jack's Ford, Current R.

Fig's 99 A and B.—*E (M.) brevicula Brittsi* (Simpson) ♀, Niangua R., Hahatonka.

Fig's 100 A and B.—*E. (Eurynia) recta* (Lamarck) ♂, Osage R., Oseola.

Fig's 100 C and D.—*E. (E.) recta* (Lam.) ♀, Meramec R., Meramec Highlands.

Fig's 101 A and B.—*E. (E.) subrostrata* (Say) ♂, Lost Cr., Maysville.

Fig's 101 C and D.—*E. (E.) subrostrata* (Say) ♀, Flat Cr., Sedalia.

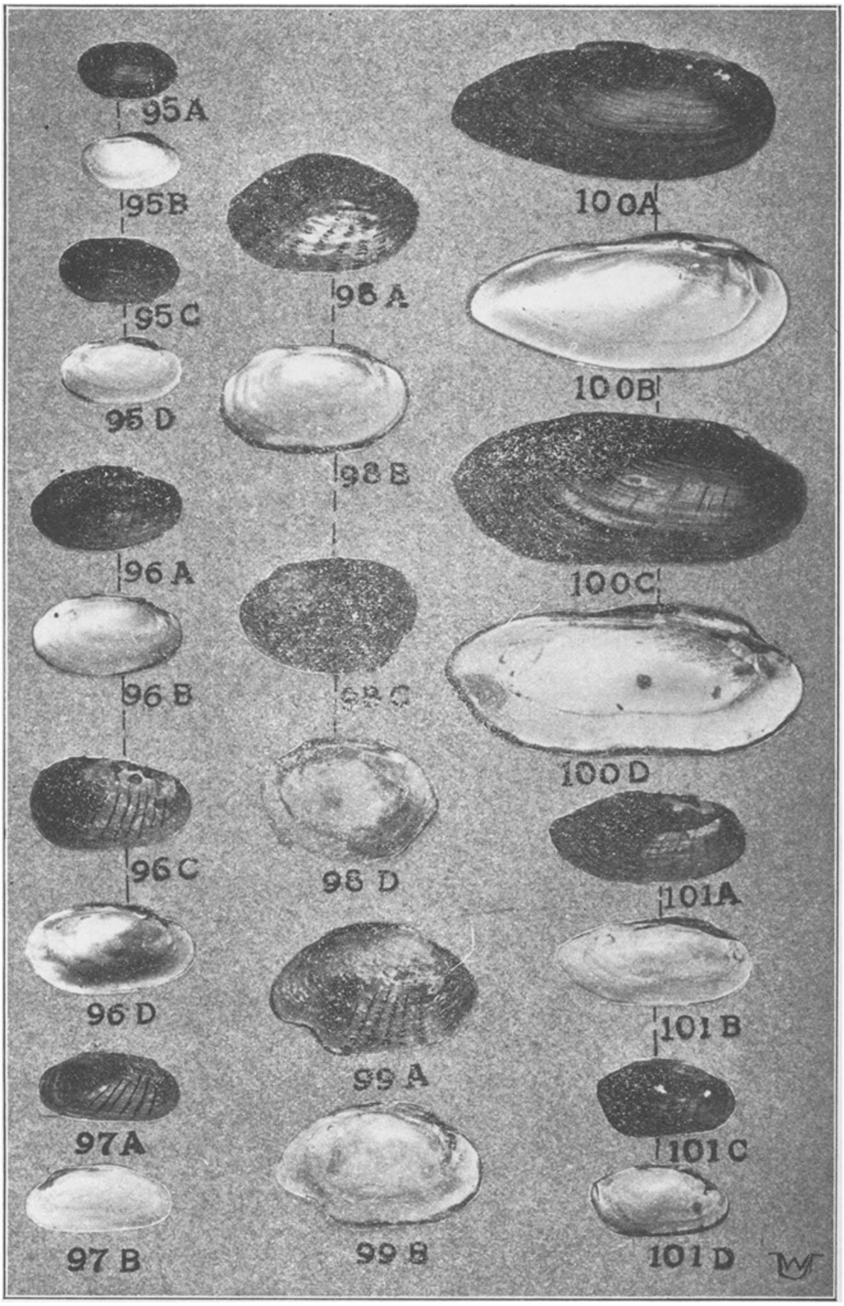

PLATE XXVII. UTTERBACK ON NAIADES OF MISSOURI

EXPLANATION OF PLATE XXVIII.

Fig's 102 A and B.—*Lampsilis anodontoides* (Lea) ♂, Chariton R., Kern.

Fig's 102 C and D.—*L. anodontoides* (Lea) ♀, Chariton R., Kern.

Fig's 103 A and B.—*L. luteola* (Lamarck) ♂, Black R., Williamsville.

Fig's 103 C and D.—*L. luteola* (Lam.) ♀, Black R., Williamsville.

Fig's 103 E and F.— Young *L. luteola* (Lam.) ♂, Black R., Williamsville.

Fig's 104 A and B.—*L. luteola rosacea* (Dekay) ♂, White R., Branson.

Fig's 105 A and B.—*L. Higginsii* (Lea) ♀, Miss. R., Hannibal.

Fig's 106 A and B.—L. *ventricosa* (Barnes) ♂, Black R., Williamsville.

Fig's 106 C and D.—*L. ventricosa* (Barnes) ♀, Miss. R., Hannibal.

Fig's 107 A and B.—*L. ventricoas satura* (Lea) ♀. White R., Hollister.

Fig's 108 A and B.—*Truncilla Lefevrei* Utterback ♀, Black R., Williamsville.

Fig's 108 C and D.—*T. Lefevrei* Utterback ♂, Black R., Williamsville.

Fig's 109 A and B.—*Truncilla curtisi* Frierson and Utterback ♀, White R., Hollister.

Fig's 109 C and D.—*T. Curtisi* F. and U. ♂, White R., Hollister.

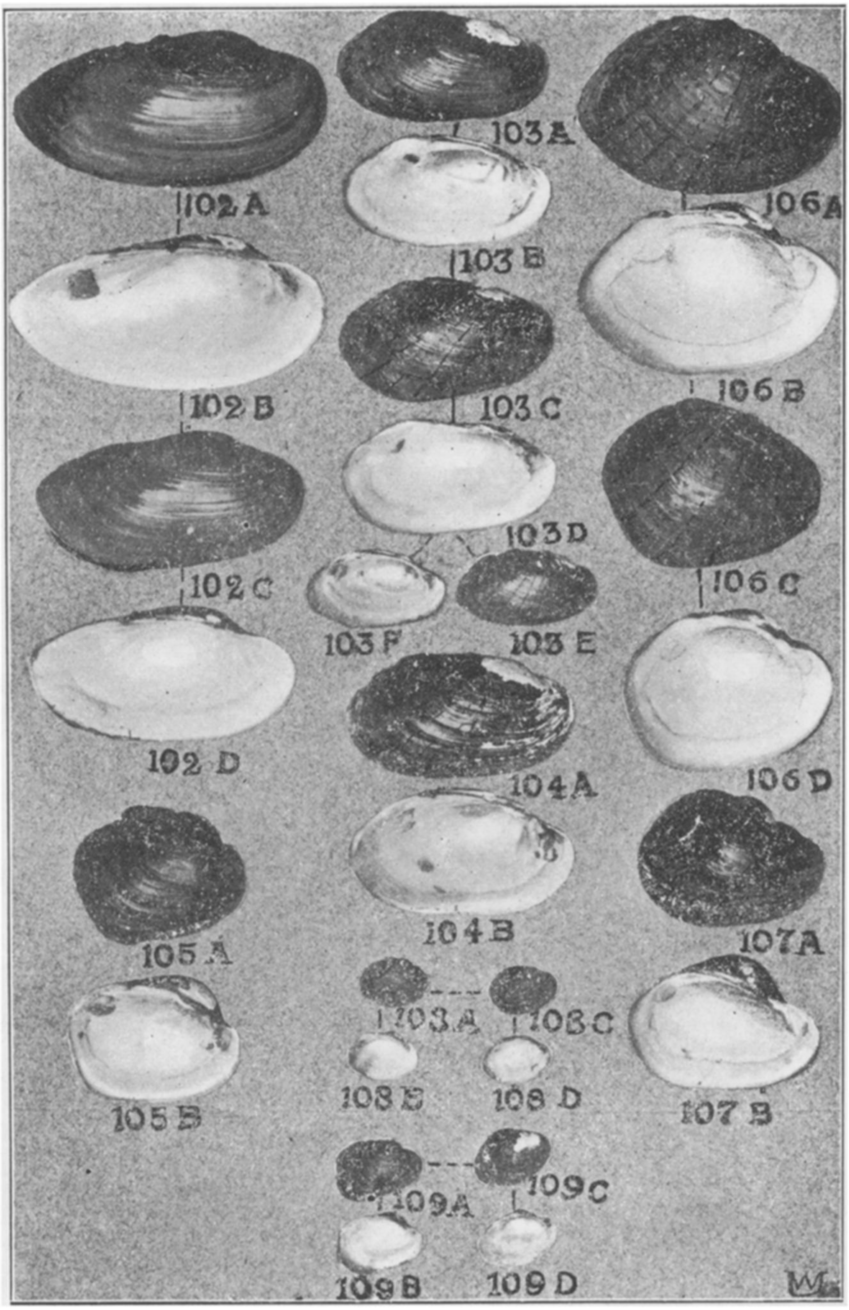

PLATE XXVIII. UTTERBACK ON NAIADES OF MISSOURI